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Note

A new method for the synthesis of ureido sugars

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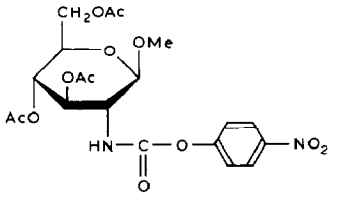
Nitrosoureas are an important class of antitumor agents[1]. Analogues of streptozotocin (*N*-nitroso-*N*-methyl urea of 2-amino-2-deoxy-D-glucose)[2,3] have been described and many other nitrosoureido sugars have been prepared[4]. Nitrosoureido sugars can be obtained easily by aqueous nitrosation of ureido sugars with sodium nitrite[3]. The most convenient method for the synthesis of ureido sugars involves the reaction of isocyanates with amino sugars[5], but few isocyanates are available commercially.

Recently, Izdebski and Pawlak[6] described a convenient new method for the synthesis of *N,N'*-disubstituted ureas and we have adopted this method for the synthesis of ureido sugars.

Bis(4-nitrophenyl) carbonate (**1**), obtained[6] by the action of phosgene on sodium 4-nitrophenolate, was reacted in dichloromethane in the presence of 1-hydroxybenzotriazole with methyl 3,4,6-tri-*O*-acetyl-2-amino-2-deoxy-β-D-glucopyranoside[7] to



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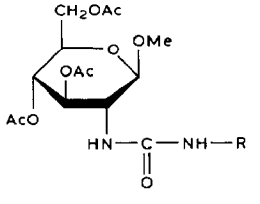
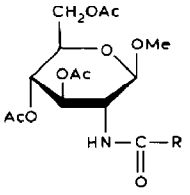


3 R = Et
4 R = Pr
5 R = ^{i}Pr
6 R = Bu
7 R = ^{i}Bu
8 R = pentyl
9 R = $CH_2CH_2CH(CH_3)_2$
10 R = $CH(CH_3)CH_2CH_2CH_2CH(CH_3)_2$
11 R = cyclohexyl
12 R = Bzl
13 R = CH_2CH_2Ph
14 R = allyl



15 R = NEt_2
16 R = $N(C_6H_{13})_2$
17 R = $N(C_6H_{11})_2$
18 R = 
19 R = 

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give the 4-nitrophenyl carbamate **2**. Reaction at room temperature was complete within 20 h and 90% of **2** was obtained.

Reaction of **2** in dichloromethane with 1 mol of an alkylamine then gave the alkylureido derivative in good yield. The structures of the ureido sugars **3–19** were confirmed by ^{1}H- and ^{13}C-n.m.r. spectroscopy.

EXPERIMENTAL

Melting points are uncorrected. Optical rotations were measured on a Perkin–Elmer Model 241 polarimeter. N.m.r. spectra (internal Me_4Si) were recorded with a Jeol FX 90Q (^{1}H: 90 MHz, ^{13}C: 22.53 MHz) spectrometer. T.l.c. was performed on Silica Gel 60 F_{254} (Merck), using chloroform–acetone (4:1) and detection by u.v. light, or charring with sulfuric acid. Column chromatography was conducted on Silica Gel 60 (Merck 230–400 mesh) in chloroform–acetone (4:1).

*Methyl 3,4,6-tri-*O*-acetyl-2-deoxy-2-(4-nitrophenoxycarbonylamino)-β-*D*-glucopyranoside* (**2**). — To a solution of bis(4-nitrophenyl) carbonate[6] (**1**; 0.91 g, 3 mmol) in dichloromethane (20 mL) were added a solution of methyl 3,4,6-tri-*O*-acetyl-2-amino-2-deoxy-β-D-glucopyranoside[7] (0.96 g, 3 mmol) in dichloromethane (20 mL) and 1-hydroxybenzotriazole (0.40 g, 3 mmol). The mixture was stirred for 20 h at room temperature; t.l.c. then revealed no **2**. The mixture was diluted with dichloromethane (50 mL), washed successively with water, M ammonia, water, M hydrochloric acid, and water, then dried, and concentrated. Column chromatography of the residue and recrystallization from chloroform–hexane yielded **2** (1.31 g, 90%), m.p. 178–180°, $[\alpha]_D^{20}$ +35° (*c* 1, chloroform). N.m.r. data ($CDCl_3$): ^{1}H, δ 8.24 (d, 2 H, *J* 9 Hz, Ph), 7.32 (d, 2 H, *J* 10 Hz, Ph), 5.37 (d, 1 H, *J* 10 Hz, NH), 5.21–5.19 (m, 2 H, H-3,4), 4.68 (d, 1 H, *J* 8 Hz, H-1), 4.42–4.19 (m, 2 H, H-6a,b), 3.81–3.64 (m, 2 H, H-2,5), 3.56 (s, 3 H, OMe), 2.09, 2.05 (2 s, 9 H, 3 Ac); ^{13}C, δ 170.78, 170.67, 169.42 (CH_3COO), 155.50 (NH*C*OO) 152.63, 144.93, 125.10, 121.90 (Ph), 101.26 (C-1), 71.84 (C-3,5), 68.43 (C-4), 61.93 (C-6), 57.21 (OMe), 56.67 (C-2), 20.75, 20.64 (CH_3OO).

Anal. Calc. for $C_{20}H_{24}N_2O_{12}$: C, 49.59; H, 4.99; N, 5.78. Found: C, 49.66; H, 5.06; N, 6.02.

*Methyl 3,4,6-tri-*O*-acetyl-2-(3-alkylureido)-2-deoxy-β-*D*-glucopyranoside.* — To a solution of **2** (1 mmol) in dichloromethane (10 mL) was added a solution of alkylamine (1 mmol) in dichloromethane (10 mL), and the mixture was stored for 5–24 h at room temperature. T.l.c. then revealed no **2**. The mixture was diluted with dichloromethane (20 mL), washed successively with water, M ammonia, water, M hydrochloric acid, and water, then dried, and concentrated. The residue was subjected to column chromatography. The following compounds were prepared in this manner.

Methyl 3,4,6-tri-*O*-acetyl-2-deoxy-2-(3-ethylureido)-β-D-glucopyranoside (**3**), methyl 3,4,6-tri-*O*-acetyl-2-deoxy-2-(3-propylureido)-β-D-glucopyranoside (**4**), methyl 3,4,6-tri-*O*-acetyl-2-deoxy-2-(3-isopropylureido)-β-D-glucopyranoside (**5**), methyl 3,4,6-tri-*O*-acetyl-2-deoxy-2-(3-butylureido)-β-D-glucopyranoside (**6**), methyl 3,4,6-tri-*O*-

TABLE I

Physico-chemical and analytical data for **3–19**

Compound	*Yield* (%)	*M.p.* *(degrees)*	$[\alpha]_D^{20}$ (c *1, chloroform)* *(degrees)*	*Formula*	*Analytical data*					
					Calc.			*Found*		
					C	*H*	*N*	*C*	*H*	*N*
3	65	116–118	+7.2	$C_{16}H_{26}N_2O_9$	49.23	6.71	7.18	49.14	6.75	7.07
4	70		+5.2	$C_{17}H_{28}N_2O_9$	50.49	6.98	6.93	50.45	7.07	6.88
5	72	152–154	+3.2	$C_{17}H_{28}N_2O_9$	50.49	6.98	6.93	50.50	7.04	7.11
6	75		+5.8	$C_{18}H_{30}N_2O_9$	51.67	7.23	6.69	51.63	7.29	6.65
7	80	123–125	+6.0	$C_{18}H_{30}N_2O_9$	51.67	7.23	6.69	51.61	7.28	6.96
8	89		+5.7	$C_{19}H_{32}N_2O_9$	52.77	7.46	6.48	52.67	7.46	6.37
9	85		+7.9	$C_{19}H_{32}N_2O_9$	52.77	7.46	6.48	52.54	7.58	6.61
10	92		+3.1	$C_{22}H_{38}N_2O_9$	55.68	8.07	5.90	55.76	8.12	6.19
11	86	176–178	+4.5	$C_{20}H_{32}N_2O_9$	54.04	7.26	6.30	54.13	7.24	6.28
12	91		+6.2	$C_{21}H_{28}N_2O_9$	55.75	6.24	6.19	55.52	6.27	6.24
13	82	127–128	+8.2	$C_{22}H_{30}N_2O_9$	56.64	6.48	6.00	56.70	6.45	5.92
14	56		+7.9	$C_{17}H_{26}N_2O_9$	50.74	6.51	6.96	50.79	6.64	7.07
15	83		+10.8	$C_{18}H_{30}N_2O_9$	51.67	7.23	6.69	51.67	7.34	6.80
16	86	102–104	+16.5	$C_{26}H_{46}N_2O_9$	58.85	8.74	5.28	58.79	8.87	5.30
17	90	156–157	+12.8	$C_{26}H_{42}N_2O_9$	59.30	8.04	5.32	59.21	8.02	5.28
18	86	154–155	+16.7	$C_{19}H_{30}N_2O_9$	53.08	7.02	6.51	53.01	6.89	6.49
19	85	179–180	+16.9	$C_{18}H_{28}N_2O_9$	51.92	6.78	6.73	51.99	6.60	6.58

TABLE II

^{13}C-N.m.r. data for **3–19** ($CDCl_3$, internal Me_4Si)

Compound	*C-1*	*C-2*	*C-3*	*C-4*	*C-5*	*C-6*	*OMe*	*CH_3COO*	*CH_3COO*	*N–CO–N*	*Remaining carbon atoms*
3	103.21	56.02	71.84	68.97	73.09	62.31	57.00	170.99, 170.67, 169.48	20.75	157.55	35.22, 15.33
4	103.21	56.02	71.68	68.75	72.93	62.20	57.11	170.99, 170.72, 169.48	20.75, 20.64	158.31	42.10, 23.30, 11.27
5	103.21	56.02	71.79	68.86	73.03	62.25	56.99	170.88, 170.61, 169.88	20.70, 20.59	157.56	42.10, 21.24
6	103.16	55.91	71.79	69.08	73.14	62.42	57.00	170.83, 170.61, 169.48	20.70, 20.54	158.42	40.15, 32.24, 20.00, 13.76
7	103.05	55.70	71.68	69.13	73.20	62.47	57.00	170.78, 170.67, 169.53	20.70, 20.59	158.64	47.79, 28.93, 19.99, 18.37
8	103.05	55.53	71.73	69.13	73.30	62.47	57.00	170.78, 170.67, 169.48	20.70	158.80	46.05, 35.32, 26.93, 22.43, 17.07
9	103.10	55.81	71.73	69.19	73.14	62.47	57.00	170.72, 170.61, 169.42	20.60	158.48	39.06, 38.68, 25.79
10	103.05	55.59	71.73	69.35	73.30	62.63	56.94	170.53, 169.61	20.70	157.99	46.00, 39.01, 37.65, 27.96, 23.89, 22.59
11	103.27	56.08	71.79	68.92	73.03	62.36	56.99	170.93, 170.67, 169.48	20.75, 20.64	157.56	48.92, 33.70, 25.68, 24.92
12	103.00	55.53	71.63	69.13	73.14	62.47	56.94	170.67, 169.42	20.64	158.53	139.79, 128.41, 127.00, 126.89, 43.09
13	103.10	56.08	71.73	68.86	72.93	62.25	57.00	170.99, 170.66, 169.42	20.70, 20.59	158.09	139.24, 128.79, 126.35, 41.61, 36.19
14	103.00	55.26	71.68	69.51	73.25	62.74	57.11	170.61, 170.40, 169.58	20.70	158.75	135.94, 114.70, 42.48
15	102.45	55.64	71.89	69.24	73.14	62.52	56.62	170.78, 170.61, 169.37	20.70	156.36	41.34, 13.71
16	102.40	55.91	71.90	69.74	72.81	62.47	56.73	170.61, 169.81	20.64	156.63	47.46, 31.64, 28.50, 26.60, 22.59, 13.98
17	102.24	55.32	71.79	69.30	72.65	62.47	56.78	170.67, 170.61, 170.40	20.70	156.41	56.18, 31.80, 31.47, 26.44, 25.52
18	102.40	55.81	71.79	69.08	73.09	62.47	56.67	170.88, 170.67, 169.42	20.75	156.74	45.13, 25.63, 24.49
19	102.40	55.53	71.79	69.03	73.30	62.42	56.62	170.89, 170.67, 169.42	20.70	156.93	45.57, 25.52

TABLE III

^{1}H-N.m.r. data (δ in p.p.m.)[a] for **3-19**

3	5.97–5.78 (m, 2 H, 2 NH), 5.01 (t, 1 H, $J_{2,3} = J_{3,4} = 10$ Hz, H-3), 4.81 (dd, 1 H, $J_{3,4}$ 10, $J_{4,5}$ 9.6 Hz, H-4), 4.52 (d 1 H, $J_{1,2}$ 8 Hz, H-1), 4.18–4.08 (m, 2 H, H-6a,6b), 3.72–3.55 (m, 2 H, H-2,5), 3.33 (s, 3 H, OMe), 2.96–2.70 (m, 2 H, CH_2), 2.01, 1.96, 1.90 (3 s, 9 H, 3 Ac), 0.96 (t, 3 H, J 8 Hz, CH_3).
4	5.92 (d, 1 H, J 12.7 Hz, NH), 5.76 (m, 1 H, NH), 5.09 (t, 1 H, $J_{2,3} = J_{3,4} = 10$ Hz, H-3), 4.80 (dd, 1 H, $J_{3,4}$ 10, $J_{4,5}$ 9.4 Hz, H-4), 4.52 (d 1 H, $J_{1,2}$ 8 Hz, H-1), 4.17–4.06 (m, 2 H, H-6a,6b), 3.97–3.75 (m, 2 H, H-2,5), 3.38 (s, 3 H, OMe), 2.93–2.75 (m, 2 H, NCH_2), 2.03, 1.97, 1.90 (3 s, 9 H, 3 Ac), 1.39–1.19 (m, 2 H, CH_2), 0.81 (t, 3 H, J 7 Hz, CH_3).
5	5.79 (d, 1 H, J 8 Hz, NH), 5.69 (d, 1 H, J 8.4 Hz, NH), 5.10 (dd, 1 H, $J_{2,3} = J_{3,4} = 10.5$ Hz, H-3), 4.82 (t, 1 H, $J_{3,4}$ 10.5, $J_{4,5}$ 9.5 Hz, H-4), 4.52 (d, 1 H, $J_{1,2}$ 8.4 Hz, H-1), 4.37–4.06 (m, 2 H, H-6a,6b), 3.93–3.57 (m, 2 H, H-2,5), 3.34 (s, 3 H, OMe), 2.95 (m, 1 H, CH), 2.02, 1.96, 1.89 (3 s, 9 H, 3 Ac), 0.99 (d, 6 H, J 6.6, 2 CH_3).
6	5.99–5.92 (m, 1 H, NH), 5.82 (d, 1 H, J 8.6 Hz, NH), 5.14 (t, 1 H, J 9.4, J 9.8 Hz, H-3), 4.84 (t, 1 H, J 9.4 and 9.8 Hz, H-4), 4.55 (d, 1 H, $J_{1,2}$ 8.4 Hz, H-1), 4.20–4.08 (m, 2 H, H-6a,6b), 3.95–3.78 (m, 2 H, H-2,5), 3.34 (s, 3 H, OMe), 2.92 (m, 2 H, NCH_2), 2.02, 1.96, 1.84 (3 s, 9 H, 3 Ac), 1.35–1.24 (m, 4 H, 2 CH_2), 0.86 (t, 3 H, J 5.6 Hz, CH_3).
7	5.91 (m, 1 H, NH), 5.75 (d, 1 H, J 8.2 Hz, NH), 5.11 (dd, 1 H, $J_{2,3}$ 10, $J_{3,4}$ 9.5 Hz, H-3), 4.80 (t, 1 H, $J_{3,4} = J_{4,5} = 9.5$ Hz, H-4), 4.50 (d, 1 H, J 8.5 Hz, H-1), 4.22–4.10 (m, 2 H, H-6a,6b), 4.00–3.47 (m, 2 H, H-2,5), 3.34 (s, 3 H, OMe), 2.85–2.52 (m, 2 H, CH_3), 2.02, 1.96, 1.88 (3 s, 9 H, 3 Ac), 1.71–1.42 (m, 1 H, CH), 0.79 (d, 6 H, J 6.6 Hz, 2 CH_3).
8	5.80 (m, 1 H, NH), 5.75 (d, 1 H, J 8.5 Hz, NH), 5.10 (t, 1 H, $J_{2,3} = J_{3,4} = 10$ Hz, H-3), 4.80 (dd, 1 H, $J_{3,4}$ 9.4, $J_{4,5}$ 10 Hz, H-4), 4.51 (d, 1 H, $J_{1,2}$ 8 Hz, H-1), 4.17–4.06 (m, 2 H, H-6a,6b), 3.88–3.51 (m, 2 H, H-2,5), 3.34 (s, 3 H, OMe), 3.10–2.67 (m, 2 H, CH_2), 2.01, 1.96, 1.89 (3 s, 9 H, 3 Ac), 1.37–1.15 (m, 4 H, 2 CH_2), 0.89–0.80 (m, 5 H, CH_2, CH_3).
9	5.09–5.72 (m, 1 H, NH), 5.76 (d, 1 H, J 9.4 Hz, NH), 5.09 (dd, 1 H, $J_{2,3}$ 10, $J_{3,4}$ 9.4 Hz, H-3), 4.80 (t, 1 H, $J_{3,4} = J_{4,5} = 9.4$ Hz, H-4), 4.51 (d, 1 H, $J_{1,2}$ 8.5 Hz, H-1), 4.23–4.05 (m, 2 H, H-6a,6b), 3.95–3.45 (m, 2 H, H-2,5), 3.34 (s, 3 H, OMe), 3.03–2.81 (m, 2 H, NCH_2), 2.01, 1.96, 1.89 (3 s, 9 H, 3 Ac), 1.70–1.20 (m, 5 H, CH, CH_2), 0.84 (d, 6 H, J 6 Hz, 2 CH_3).
10	5.67 (d, 1 H, J 9.4 Hz, NH), 5.09 (dd, 1 H, $J_{2,3} = J_{3,4} = 10$ Hz, H-3), 4.80 (t, 1 H, $J_{3,4} = J_{4,5} = 10$ Hz, H-4), 4.52 (d, 1 H, $J_{1,2}$ 8.5 Hz, H-1), 4.51 (d, 1 H, J 8.6 Hz, NH), 4.50–4.06 (m, 2 H, H-6a,6b), 3.78–3.64 (m, 3 H, H-2,5, NCH), 3.35 (s, 3 H, OMe), 2.02, 1.97, 1.90 (3 s, 9 H, 3 Ac), 1.51–1.11 (m, 7 H, CH, 3 CH_2), 0.97 (d, 3 H, J 6.6 Hz, CH_3), 0.85 (d, 6 H, J 6.6 Hz, 2 CH_3).
11	5.83 (d, 1 H, J 10 Hz, NH), 5.72 (d, 1 H, J 10 Hz, NH), 5.11 (dd, 1 H, $J_{2,3}$ 10, $J_{3,4}$ 9.4 Hz, H-3), 4.82 (dd, 1 H, $J_{3,4}$ 9.4, $J_{4,5}$ 10.3 Hz, H-4), 4.52 (d, 1 H, $J_{1,2}$ 8.5 Hz, H-1), 4.26–4.07 (m, 2 H, H-6a,6b), 3.97–3.48 (m, 3 H, H-2,5, CH), 3.36 (s, 3 H, OMe), 2.04, 1.98, 1.91 (3 s, 9 H, 3 Ac), 1.72–1.17 (m, 10 H, 5 CH_2).
12[b]	7.25 (m, 5 H, Ph), 5.18–4.94 (m, 3 H, H-3,4, NH), 4.40 (d, 1 H, $J_{1,2}$ 8.5 Hz, H-1), 4.37–4.16 (m, 5 H, H-6a,6b, CH_2, NH), 3.46 (s, 3 H, OMe), 2.07, 2.00, 1.98 (3 s, 9 H, 3 Ac).
13	7.28–7.22 (m, 5 H, Ph), 5.97–5.88 (m, 2 H, 2 NH), 5.11 (dd, 1 H, $J_{2,3}$ 9.9, $J_{3,4} = 9.4$ Hz, H-3), 4.88 (t, 1 H, $J_{2,3} = J_{4,5} = 9.4$ Hz, H-4), 4.52 (d, 1 H, $J_{1,2}$ 8 Hz, H-1), 4.29–4.08 (m, 2 H, H-6a,6b), 4.29–4.09 (m, 2 H, H-2,5), 3.35 (s, 3 H, OMe), 3.30–3.15 (m, 2 H, NCH_2), 2.72–2.58 (t, 2 H, J 7 Hz, CH_2), 2.02, 1.98, 1.90 (3 s, 9 H, 3 Ac).
14	6.09–5.63 (m, 3 H, 2 NH, =CH), 5.12 (dd, 1 H, J 10 and 9.4 Hz, H-3), 5.03, 5.01 (2 d, 2 H, J 8.5 Hz, $=CH_2$), 4.82 (dd, 1 H, J 10 and 9.4 Hz, H-4), 4.54 (d, 1 H, $J_{1,2}$ 8.5 Hz, H-1), 4.31–4.07 (m 2 H, H-6a,6b), 3.97–3.50 (m, 4 H, H-2,5, CH_2), 3.37 (s, 3 H, OMe), 2.04, 1.99, 1.92 (3 s, 9 H, 3 Ac).
15	6.15 (d, 1 H, J 9 Hz, NH), 5.19 (t, 1 H, $J_{2,3} = J_{3,4} = 10$ Hz, H-3), 4.82 (dd, 1 H, $J_{3,4}$ 10, $J_{4,5}$ 9.4 Hz, H-4), 4.62 (d, 1 H, $J_{1,2}$ 8 Hz, H-1), 4.26–4.07 (m, 2 H, H-6a,6b), 3.85–3.62 (m, 2 H, H-2,5), 3.35 (s, 3 H, OMe), 2.03, 1.97, 1.88 (3 s, 9 H, 3 Ac), 0.98 (2 t, 6 H, J 7.0 Hz, 2 CH_3).
16[b]	5.42 (dd, 1 H, J 8.4 and 8.9 Hz, H-3), 5.05 (dd, 1 H, J 8.4 and 8.9 Hz, H-4), 4.71 (d, 1 H, $J_{1,2}$ 8.5 Hz, H-1), 4.41 (d, 1 H, J 8 Hz, NH), 4.26–4.17 (m, 2 H, H-6a,6b), 3.80–3.55 (m, 2 H, H-2,5), 3.52 (s, 3 H, OMe), 2.08, 2.00 (2 s, 9 H, 3 Ac), 1.76–1.02 (m, 16 H, 8 CH_2), 0.89 (t, 6 H, J 4.7 Hz, 2 CH_3).

17[b]	5.54 (dd, 1 H, *J* 8.9 and 10.3 Hz, H-3), 5.05 (dd, 1 H, *J* 8.9 and 10.3 Hz, H-4), 4.86 (d, 1 H, $J_{1,2}$ 8 Hz, H-1), 4.37 (d, 1 H, *J* 8 Hz, NH), 4.27–4.08 (m, 2 H, H-6a,6b), 3.82–3.62 (m, 2 H, H-2,5), 3.52 (s, 3 H, OMe), 3.40–3.25 (m, 2 H, 2 CH), 2.08, 2.01 (2 s, 9 H, 3 Ac), 1.81–1.68 (m, 20 H, 10 CH_2).
18[b]	5.37 (dd, 1 H, $J_{2,3}$ 10, $J_{3,4}$ 9.4 Hz, H-3), 5.07 (t, 1 H, $J_{3,4} = J_{4,5}$ = 10 Hz, H-4), 4.77 (d, 1 H, *J* 9 Hz, NH), 4.68 (d, 1 H, $J_{1,2}$ 8 Hz, H-1), 4.27–4.17 (m, 2 H, H-6a,6b), 3.81–3.63 (m, 2 H, H-2,5), 3.51 (s, 3 H, OMe), 3.33 (m, 4 H, 2 CH_2), 2.05, 2.02 (2 s, 9 H, 3 Ac), 1.56 (m, 6 H, 3 CH_2).
19[b]	5.33 (dd, 1 H, $J_{2,3}$ 10, $J_{3,4}$ 9.4 Hz, H-3), 5.07 (t, 1 H, $J_{3,4} = J_{4,5}$ = 9.4 Hz, H-4), 4.39 (d, 1 H, *J* 10 Hz, NH), 4.65 (d, 1 H, $J_{1,2}$ 8 Hz, H-1), 4.26–4.17 (m, 2 H, H-6a,6b), 3.90–3.64 (m, 2 H, H-2,5), 3.51 (s, 3 H, OMe), 3.36–3.22 (m, 4 H, 2 CH_2), 2.09, 1.95 (2 s, 9 H, 3 Ac), 1.92–1.82 (m, 4 H, 2 CH_2).

[a] For a solution in $(CD_3)_2SO$ (internal Me_4Si). [b] For a solution in $CDCl_3$.

acetyl-2-deoxy-2-(3-isobutylureido)-β-D-glucopyranoside (**7**), methyl 3,4,6-tri-*O*-acetyl-2-deoxy-2-(3-pentylureido)-β-D-glucopyranoside (**8**), methyl 3,4,6-tri-*O*-acetyl-2-deoxy-2-(3-isopentylureido)-β-D-glucopyranoside (**9**), methyl 3,4,6-tri-*O*-acetyl-2-deoxy-2-[3-(1,5-dimethylhexyl)ureido]-β-D-glucopyranoside (**10**), methyl 3,4,6-tri-*O*-acetyl-2-(3-cyclohexylureido)-2-deoxy-β-D-glucopyranoside (**11**), methyl 3,4,6-tri-*O*-acetyl-2-(3-benzylureido)-2-deoxy-β-D-glucopyranoside (**12**), methyl 3,4,6-tri-*O*-acetyl-2-deoxy-2-(3-phenethylureido)-β-D-glucopyranoside (**13**), methyl 3,4,6-tri-*O*-acetyl-2-(3-allylureido)-2-deoxy-β-D-glucopyranoside (**14**), methyl 3,4,6-tri-*O*-acetyl-2-deoxy-2-(3,3-diethylureido)-β-D-glucopyranoside (**15**), methyl 3,4,6-tri-*O*-acetyl-2-deoxy-2-(3,3-dihexylureido)-β-D-glucopyranoside (**16**), methyl 3,4,6-tri-*O*-acetyl-2-deoxy-2-(3,3-dicyclohexylureido)-β-D-glucopyranoside (**17**), methyl 3,4,6-tri-*O*-acetyl-2-deoxy-2-(3-piperidinoureido)-β-D-glucopyranoside (**18**), and methyl 3,4,6-tri-*O*-acetyl-2-deoxy-2-(3-pyrrolidinoureido)-β-D-glucopyranoside (**19**). The yields and structural data for these compounds are shown in Tables I–III.

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