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2-Acetamido-*N*-benzyl-1,4-imino-1,2,4-trideoxy-L-ribitol

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Key indicators

Single-crystal X-ray study
T = 190 K
Mean σ(C–C) = 0.003 Å
R factor = 0.034
wR factor = 0.086
Data-to-parameter ratio = 9.7

For details of how these key indicators were automatically derived from the article, see http://journals.iucr.org/e.

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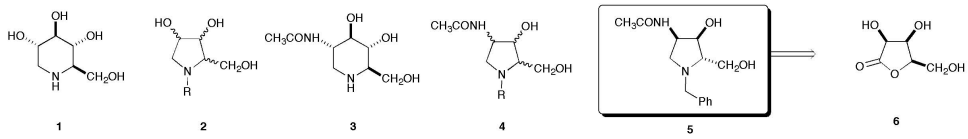
The relative configuration of the stereocentres in a potential hexosaminidase inhibitor, $C_{14}H_{20}N_2O_3$, prepared from D-lyxonolactone, has been established using X-ray crystallographic techniques.

Comment

Imino sugars, analogues of carbohydrates with the O atom of the ring replaced by an N atom, are a family of both natural products and synthetic materials which inhibit glycosidases; several such compounds have considerable therapeutic potential (Watson *et al.*, 2001; Asano *et al.*, 2000; Winchester & Fleet, 2000). For example, the natural product deoxynojirimycin, (1), is an inhibitor of a range of α-glucosidases and its derivatives have been shown to possess antiviral activity (Stütz, 1999); several related pyrrolidines, (2), are also potent inhibitors of α-glucosidases, although structure–activity relationships are not easily predictable (Asano *et al.*, 2005; Yu *et al.*, 2004; Scofield *et al.*, 1986). The synthetic *N*-acetylglucosamine analogue, (3), is a powerful hexosaminidase inhibitor (Fleet *et al.*, 1986; Boshagen *et al.*, 1987); such inhibitors have potential as anticancer agents (Woynarowska *et al.*, 1992) and for the treatment of other diseases (Liu *et al.*, 2004). By analogy with the glucosidase inhibitors, (2), a synthetic programme towards a series of diastereomeric pyrrolidines, (4), has led to the preparation of the potential hexosaminidase inhibitor, (5). While the absolute configuration of (5) is established by the use of D-lyxonolactone, (6), as the starting material, ambiguity in the relative configuration of the nitrogen substituent was removed by X-ray crystallographic analysis.



Experimental

The title compound was crystallized by cooling a warm solution in acetonitrile, forming clear block-like crystals.

Crystal data

$C_{14}H_{20}N_2O_3$
M_r = 264.32
Monoclinic, $P2_1$
a = 6.8912 (3) Å
b = 7.3504 (3) Å
c = 13.6824 (6) Å
β = 90.822 (2)°
V = 692.98 (5) Å^3
Z = 2
D_x = 1.267 Mg m^{-3}
Mo $K\alpha$ radiation
Cell parameters from 1415 reflections
θ = 1–27°
μ = 0.09 mm^{-1}
T = 190 K
Block, colourless
0.20 × 0.20 × 0.10 mm

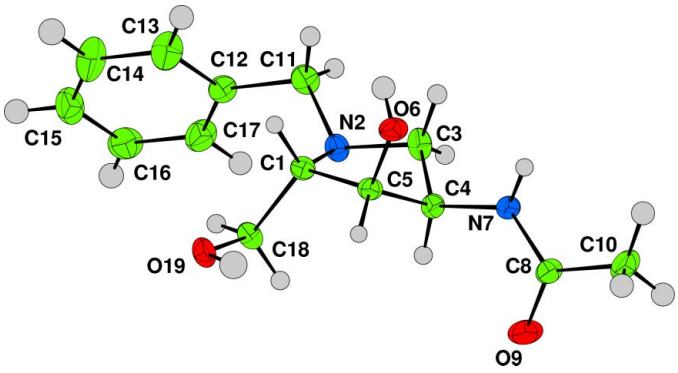


Figure 1
The molecular structure of the title compound, with displacement ellipsoids drawn at the 50% probability level.

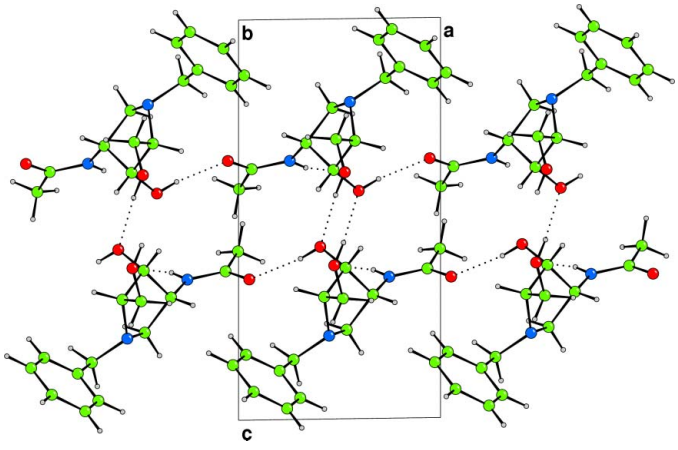


Figure 2
Packing diagram, viewed down the *b* axis. The crystal structure consists of strongly hydrogen-bonded ribbons of molecules along the *b* axis, held together by a mixture of hydrogen bonding along the *a* axis and weaker intermolecular interactions. Hydrogen bonds are represented as dotted lines.

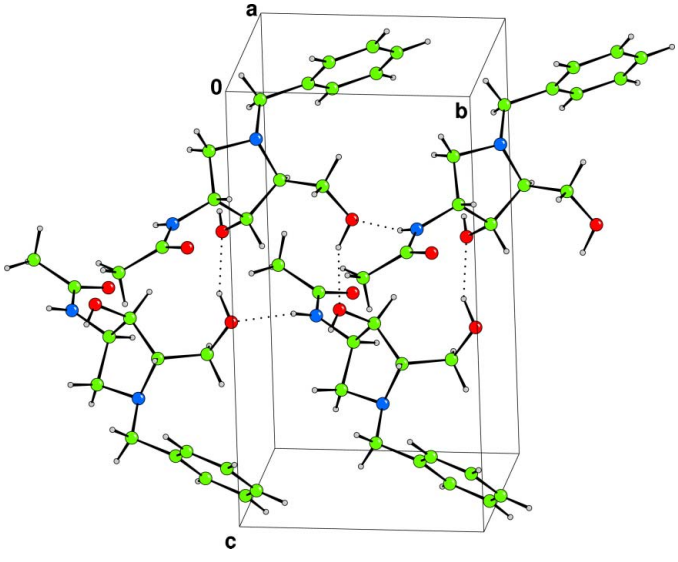


Figure 3
View of the strong hydrogen-bonding network in one of the ribbons running parallel to the *b* axis. Hydrogen bonds are represented as dotted lines.

Data collection

Nonius KappaCCD diffractometer
ω scans
Absorption correction: multi-scan (*DENZO*/*SCALEPACK*; Otwinowski & Minor, 1997)
T_{min} = 0.98, T_{max} = 0.99
2636 measured reflections
1681 independent reflections
1499 reflections with $I > 2\sigma(I)$
R_{int} = 0.020
θ_{max} = 27.5°
$h = -8 \rightarrow 8$
$k = -9 \rightarrow 8$
$l = -17 \rightarrow 17$

Refinement

Refinement on F^2
$R[F^2 > 2\sigma(F^2)]$ = 0.034
$wR(F^2)$ = 0.086
S = 0.89
1673 reflections
172 parameters
H-atom parameters constrained
$w = [1 - (F_o - F_c)^2/36\sigma^2(F_o)]^2/[33.1T_0(x) + 52.7T_1(x) + 30.8T_2(x) + 12.9T_3(x) + 3.03T_4(x)]$, where $x = F_c/F_{max}$ and $T_i(x)$ are Chebychev polynomials (Watkin, 1994; Prince, 1982)
$(\Delta/\sigma)_{max} < 0.001$
$\Delta\rho_{max}$ = 0.23 e Å^{-3}
$\Delta\rho_{min}$ = −0.20 e Å^{-3}

Table 1
Hydrogen-bond geometry (Å, °).

D—H···A	D—H	H···A	D···A	D—H···A
N7—H8···O19^{i}	0.84	2.14	2.958 (2)	167
O19—H15···O6^{ii}	0.93	1.85	2.708 (2)	153
O6—H17···O9^{iii}	0.80	1.89	2.685 (2)	168

Symmetry codes: (i) $x, y-1, z$; (ii) $-x+1, y+\frac{1}{2}, -z+1$; (iii) $x-1, y, z$.

All H atoms were observed in a difference electron-density map. The hydroxy and amide H atoms were refined freely, whilst the others were refined with slack restraints to optimize the geometry. They were all then made to ride on their parent atoms, with C—H distances of 0.96–1.00 Å and U_{iso}(H) = 1.2U_{eq}(parent). In the absence of significant anomalous scattering effects, Friedel pairs were merged; the absolute configuration is known from the synthesis. Eight low-angle reflections were omitted from the refinement because they appeared to be obscured by the beamstop.

Data collection: *COLLECT* (Nonius, 1997); cell refinement: *DENZO*/*SCALEPACK* (Otwinowski & Minor, 1997); data reduction: *DENZO*/*SCALEPACK*; program(s) used to solve structure: *SIR92* (Altomare *et al.*, 1994); program(s) used to refine structure: *CRYSTALS* (Betteridge *et al.*, 2003); molecular graphics: *CAMERON* (Watkin *et al.*, 1996); software used to prepare material for publication: *CRYSTALS*.

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supporting information

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Monoclinic, $P2_1$
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$b = 7.3504$ (3) Å
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$\beta = 90.822$ (2)°
$V = 692.98$ (5) Å^3
$Z = 2$
$F(000) = 284$
$D_x = 1.267$ Mg m^{-3}
Mo $K\alpha$ radiation, $\lambda = 0.71073$ Å
Cell parameters from 1415 reflections
$\theta = 1$–27°
$\mu = 0.09$ mm^{-1}
$T = 190$ K
Block, colourless
0.20 × 0.20 × 0.10 mm

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$R_{int} = 0.020$
$\theta_{max} = 27.5°$, $\theta_{min} = 1.5°$
$h = -8 \rightarrow 8$
$k = -9 \rightarrow 8$
$l = -17 \rightarrow 17$

Refinement

Refinement on F^2
Least-squares matrix: full
$R[F^2 > 2\sigma(F^2)] = 0.034$
$wR(F^2) = 0.086$
$S = 0.89$
1673 reflections
172 parameters
1 restraint
Primary atom site location: structure-invariant direct methods
Hydrogen site location: inferred from neighbouring sites
H-atom parameters constrained
$w = [1\text{-}(F_o\text{-}F_c)^2/36\sigma^2(F_o)]^2/ [33.1T_0(x) + 52.7T_1(x) + 30.8T_2(x) + 12.9T_3(x) + 3.03T_4(x)]$, where $x = F_c/F_{max}$ and $T_i(x)$ are Chebychev polynomials (Watkin, 1994; *P*rince, 1982)
$(\Delta/\sigma)_{max} = 0.000293$
$\Delta\rho_{max} = 0.23$ e Å^{-3}
$\Delta\rho_{min} = -0.20$ e Å^{-3}

Fractional atomic coordinates and isotropic or equivalent isotropic displacement parameters (Å^2)

	x	*y*	*z*	U_{iso}*/U_{eq}
C1	0.4242 (3)	0.6215 (3)	0.69450 (14)	0.0199
N2	0.4490 (3)	0.5333 (2)	0.79181 (12)	0.0222

C3	0.5356 (3)	0.3527 (3)	0.77759 (15)	0.0262
C4	0.6657 (3)	0.3880 (3)	0.69059 (14)	0.0217
C5	0.5299 (3)	0.4963 (3)	0.62235 (14)	0.0195
O6	0.40451 (19)	0.3757 (2)	0.56955 (10)	0.0235
N7	0.7464 (2)	0.2265 (3)	0.64659 (13)	0.0238
C8	0.9353 (3)	0.2105 (3)	0.62727 (14)	0.0231
O9	1.0531 (2)	0.3314 (3)	0.64842 (13)	0.0350
C10	0.9973 (3)	0.0385 (4)	0.57773 (18)	0.0353
C11	0.2725 (3)	0.5279 (3)	0.85049 (15)	0.0271
C12	0.2036 (3)	0.7160 (3)	0.87761 (14)	0.0244
C13	0.0365 (4)	0.7877 (4)	0.83651 (18)	0.0377
C14	−0.0277 (4)	0.9605 (4)	0.8619 (2)	0.0460
C15	0.0746 (4)	1.0630 (4)	0.92943 (19)	0.0392
C16	0.2405 (4)	0.9911 (4)	0.9721 (2)	0.0401
C17	0.3054 (3)	0.8199 (4)	0.94605 (18)	0.0341
C18	0.5168 (3)	0.8102 (3)	0.69904 (14)	0.0231
O19	0.4740 (2)	0.9199 (2)	0.61627 (11)	0.0260
H11	0.2843	0.6306	0.6748	0.0234*
H31	0.4369	0.2583	0.7617	0.0301*
H32	0.6081	0.3157	0.8355	0.0296*
H41	0.7736	0.4659	0.7110	0.0263*
H51	0.6045	0.5678	0.5745	0.0223*
H101	1.1185	−0.0062	0.6045	0.0424*
H102	1.0191	0.0636	0.5097	0.0433*
H103	0.9008	−0.0577	0.5807	0.0425*
H111	0.1680	0.4661	0.8139	0.0314*
H112	0.3003	0.4585	0.9100	0.0306*
H131	−0.0382	0.7154	0.7899	0.0452*
H141	−0.1480	1.0100	0.8313	0.0545*
H151	0.0289	1.1840	0.9480	0.0462*
H161	0.3130	1.0614	1.0212	0.0478*
H171	0.4252	0.7699	0.9749	0.0416*
H181	0.4672	0.8727	0.7581	0.0277*
H182	0.6578	0.7973	0.7054	0.0276*
H8	0.6680	0.1454	0.6289	0.0246*
H15	0.5200	0.8675	0.5597	0.0596*
H17	0.3069	0.3522	0.5983	0.0425*

Atomic displacement parameters (Å²)

	U^{11}	U^{22}	U^{33}	U^{12}	U^{13}	U^{23}
C1	0.0200 (9)	0.0199 (10)	0.0198 (9)	−0.0007 (8)	0.0015 (7)	0.0013 (8)
N2	0.0270 (8)	0.0193 (8)	0.0203 (8)	0.0014 (7)	0.0035 (6)	0.0004 (7)
C3	0.0337 (11)	0.0211 (11)	0.0238 (9)	0.0053 (9)	0.0015 (8)	−0.0009 (8)
C4	0.0189 (9)	0.0188 (10)	0.0274 (9)	0.0003 (8)	−0.0004 (7)	−0.0040 (8)
C5	0.0181 (8)	0.0193 (10)	0.0211 (9)	−0.0023 (8)	0.0016 (7)	−0.0021 (8)
O6	0.0199 (7)	0.0264 (8)	0.0243 (7)	−0.0044 (6)	0.0020 (5)	−0.0070 (6)
N7	0.0172 (8)	0.0195 (8)	0.0348 (9)	−0.0011 (7)	0.0004 (6)	−0.0052 (8)

C8	0.0184 (9)	0.0259 (10)	0.0249 (9)	0.0006 (8)	0.0006 (7)	−0.0016 (9)
O9	0.0223 (7)	0.0384 (10)	0.0445 (9)	−0.0081 (7)	0.0049 (6)	−0.0110 (8)
C10	0.0229 (10)	0.0357 (13)	0.0474 (13)	0.0049 (10)	0.0051 (9)	−0.0145 (12)
C11	0.0337 (11)	0.0248 (11)	0.0230 (9)	−0.0006 (9)	0.0074 (8)	−0.0002 (9)
C12	0.0265 (10)	0.0269 (10)	0.0200 (8)	0.0000 (9)	0.0072 (7)	−0.0008 (9)
C13	0.0404 (13)	0.0400 (14)	0.0325 (12)	0.0081 (12)	−0.0079 (10)	−0.0066 (11)
C14	0.0498 (15)	0.0455 (17)	0.0424 (14)	0.0198 (13)	−0.0066 (12)	−0.0015 (13)
C15	0.0488 (14)	0.0281 (13)	0.0413 (13)	0.0058 (12)	0.0158 (11)	−0.0026 (11)
C16	0.0353 (12)	0.0386 (14)	0.0466 (14)	−0.0049 (12)	0.0061 (11)	−0.0150 (12)
C17	0.0282 (10)	0.0369 (13)	0.0372 (12)	0.0021 (11)	−0.0006 (9)	−0.0113 (11)
C18	0.0281 (10)	0.0176 (10)	0.0236 (9)	−0.0020 (8)	0.0012 (7)	0.0001 (8)
O19	0.0322 (8)	0.0176 (7)	0.0284 (7)	0.0028 (6)	0.0031 (6)	0.0046 (6)

Geometric parameters (Å, º)

C1—N2	1.489 (2)	C10—H102	0.963
C1—C5	1.540 (3)	C10—H103	0.972
C1—C18	1.527 (3)	C11—C12	1.510 (3)
C1—H11	1.000	C11—H111	0.983
N2—C3	1.470 (3)	C11—H112	0.978
N2—C11	1.467 (3)	C12—C13	1.379 (3)
C3—C4	1.523 (3)	C12—C17	1.391 (3)
C3—H31	0.993	C13—C14	1.391 (4)
C3—H32	0.970	C13—H131	0.972
C4—C5	1.535 (3)	C14—C15	1.378 (4)
C4—N7	1.446 (3)	C14—H141	0.993
C4—H41	0.976	C15—C16	1.382 (4)
C5—O6	1.427 (2)	C15—H151	0.979
C5—H51	0.989	C16—C17	1.384 (4)
O6—H17	0.803	C16—H161	0.978
N7—C8	1.337 (2)	C17—H171	0.981
N7—H8	0.838	C18—O19	1.418 (2)
C8—O9	1.235 (3)	C18—H181	0.995
C8—C10	1.500 (3)	C18—H182	0.979
C10—H101	0.965	O19—H15	0.925
N2—C1—C5	105.3 (2)	H101—C10—H102	106.6
N2—C1—C18	108.5 (2)	C8—C10—H103	113.3
C5—C1—C18	111.6 (2)	H101—C10—H103	109.0
N2—C1—H11	111.50	H102—C10—H103	107.3
C5—C1—H11	109.3	N2—C11—C12	112.1 (2)
C18—C1—H11	110.6	N2—C11—H111	109.9
C1—N2—C3	108.5 (2)	C12—C11—H111	108.6
C1—N2—C11	114.6 (2)	N2—C11—H112	108.4
C3—N2—C11	112.9 (2)	C12—C11—H112	109.4
N2—C3—C4	101.2 (2)	H111—C11—H112	108.4
N2—C3—H31	112.5	C11—C12—C13	120.9 (2)
C4—C3—H31	110.9	C11—C12—C17	120.7 (2)

N2—C3—H32	110.5	C13—C12—C17	118.4 (2)
C4—C3—H32	112.6	C12—C13—C14	120.9 (2)
H31—C3—H32	109.0	C12—C13—H131	119.3
C3—C4—C5	101.7 (2)	C14—C13—H131	119.8
C3—C4—N7	114.8 (2)	C13—C14—C15	120.3 (2)
C5—C4—N7	114.0 (2)	C13—C14—H141	119.7
C3—C4—H41	109.3	C15—C14—H141	119.9
C5—C4—H41	109.0	C14—C15—C16	119.1 (2)
N7—C4—H41	107.8	C14—C15—H151	120.5
C1—C5—C4	102.1 (2)	C16—C15—H151	120.4
C1—C5—O6	114.0 (2)	C15—C16—C17	120.5 (2)
C4—C5—O6	110.2 (2)	C15—C16—H161	119.9
C1—C5—H51	111.2	C17—C16—H161	119.6
C4—C5—H51	111.1	C12—C17—C16	120.7 (2)
O6—C5—H51	108.2	C12—C17—H171	118.6
C5—O6—H17	113.1	C16—C17—H171	120.7
C4—N7—C8	122.4 (2)	C1—C18—O19	113.7 (2)
C4—N7—H8	117.0	C1—C18—H181	107.7
C8—N7—H8	120.4	O19—C18—H181	108.5
N7—C8—O9	121.9 (2)	C1—C18—H182	109.2
N7—C8—C10	116.6 (2)	O19—C18—H182	108.7
O9—C8—C10	121.5 (2)	H181—C18—H182	108.9
C8—C10—H101	111.5	C18—O19—H15	111.2
C8—C10—H102	108.9		

Hydrogen-bond geometry (Å, º)

D—H···*A*	*D*—H	H···*A*	*D*···*A*	*D*—H···*A*
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