Acta Crystallographica Section E
Structure Reports Online
ISSN 1600-5368

1-[(4a*S*,5*R*,7*R*,7a*S*)-7-Hydroxymethyl-3,4,4a,5,7,7a-hexahydro-2*H*-furo[3,4-*b*]-[1,4]thiazin-5-yl]pyrimidine-2,4(1*H*,3*H*)-dione

Jing-Bo Sun, Hua Yang and Jin-Chang Wu*

Chemistry College, Jilin University, Changchun 130012, People's Republic of China

Correspondence e-mail: jcwu@jlu.edu.cn

Received 10 January 2007
Accepted 19 January 2007

The title compound, $C_{11}H_{15}N_3O_6S$, is a 2′,3′-thiazine-fused bicyclic nucleoside. The furanose ring adopts a 3′-*endo*,4′-*exo* conformation ${}_4T^3$. The orientation of the pyrimidine ring is *anti* with respect to the sugar group. The crystal packing is stabilized by intermolecular N—H···O hydrogen bonds.

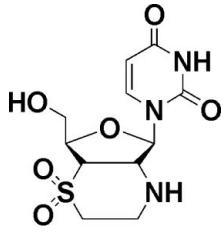
Key indicators

Single-crystal X-ray study
T = 285 K
Mean σ(C–C) = 0.004 Å
R factor = 0.041
wR factor = 0.108
Data-to-parameter ratio = 14.9

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

Comment

A large number of 2′,3′-modified nucleosides have been synthesized for the evaluation of their biological activities, revealing that the conformational equilibrium of the sugar unit is a key factor responsible for biological effects (Meldgaard & Wengel, 2000; Len & Mackenzie, 2006). The synthesis of 2′,3′-fused bicyclic nucleosides, the analogues conformationally restricted on the sugar ring, has been used as a tool to probe the conformational requirements of key enzymes in order to maximize the therapeutic index of nucleoside antiviral agents (Vanheusden *et al.*, 2004; Sharma *et al.*, 2004). Here we report the crystal structure of a new bicyclic nucleoside, (I), recently synthesized in our laboratory. Compound, (I), is a 2′,3′-α-fused tetrahydrothiazine nucleoside synthesized *via* intramolecular Michael addition of an amino nucleophile to vinyl sulfone.



(I)

In (I) (Fig. 1), the five-membered ribose ring C7/C3/C4/C5/O4 adopts an approximate ${}_4T^3$ conformation, with a pseudorotational phase angle (*P*) of 36.9 (2)° and puckering amplitude (τ^m) of 49.9 (3)° (Sanger, 1984; Altona & Sundaralingam,1972; Altona & Sundaralingam, 1973). The glycosydic torsion angle χ of −160.2 (2)° shows the orientation of the pyrimidine ring to be *anti* with respect to the sugar group. The torsion angle γ (C4—C5—C6—O3) is 51.9 (4)°. The C4—S1 and C3—N1 bond lengths are 1.776 (3) and 1.442 (4) Å, respectively. The fused six-membered tetrahydrothiazine ring adopts a chair conformation. The crystal packing is stabilized by intermolecular N—H···O hydrogen bonds (Table 1).

The absolute stereochemistry of atoms C3, C4, C5 and C7 has been unambiguously determined to be *S*, *S*, *R* and *R*, respectively, by refining the Flack (1983) parameter.

Experimental

The title compound was synthesized from 1-[5′-hydroxy-2′,3′-dideoxy-3′-(2-aminoethylsulfonyl)-β-D-glyceropent-2′-enofuranosyl]-uracil *via* intramolecular Michael addition (details will be published elsewhere). It was crystallized slowly from a mixture of ethanol and methanol (1:1) at 298 K.

Crystal data

$C_{11}H_{15}N_3O_6S$
M_r = 317.32
Monoclinic, $P2_1$
a = 5.365 (4) Å
b = 7.130 (5) Å
c = 17.272 (14) Å
β = 90.39 (3)°
V = 660.7 (9) Å^3
Z = 2
D_x = 1.595 Mg m^{-3}
Mo $K\alpha$ radiation
μ = 0.28 mm^{-1}
T = 285 (2) K
Block, yellow
0.34 × 0.23 × 0.14 mm

Data collection

Rigaku R-AXIS RAPID diffractometer
ω scans
Absorption correction: multi-scan (*ABSCOR*; Higashi, 1995)
T_{min} = 0.917, T_{max} = 0.966
6286 measured reflections
2893 independent reflections
2342 reflections with $I > 2\sigma(I)$
R_{int} = 0.032
θ_{max} = 27.5°

Refinement

Refinement on F^2
$R[F^2 > 2\sigma(F^2)]$ = 0.041
$wR(F^2)$ = 0.108
S = 1.08
2893 reflections
194 parameters
H atoms treated by a mixture of independent and constrained refinement
$w = 1/[\sigma^2(F_o^2) + (0.0595P)^2]$ where $P = (F_o^2 + 2F_c^2)/3$
$(\Delta/\sigma)_{max} < 0.001$
$\Delta\rho_{max}$ = 0.32 e Å^{-3}
$\Delta\rho_{min}$ = −0.27 e Å^{-3}
Absolute structure: Flack (1983), 1263 Friedel pairs
Flack parameter: 0.00 (9)

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

D—H···A	D—H	H···A	D···A	D—H···A
N3—H3A···O6^{i}	0.86	1.92	2.769 (4)	171
N1—H1···O3^{ii}	1.00 (4)	2.58 (4)	3.410 (5)	141 (3)
O3—H3B···O5^{iii}	0.82	2.69	3.112 (4)	114

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

The C-bound H atoms were positioned geometrically (C—H = 0.93–0.98 Å) and treated as riding on their parent atoms, with U_{iso}(H) = 1.2U_{eq}(C). The hydroxy H atom was treated as riding on its parent atom, with O–H = 0.82 Å and U_{iso}(H) = 1.5U_{eq}(O). H3A was positioned geometrically and allowed to ride on N3, with U_{iso}(H) = 1.2U_{eq}(N3). H1 was located in a difference Fourier map and refined freely, with U_{iso}(H) = 1.2U_{eq}(N).

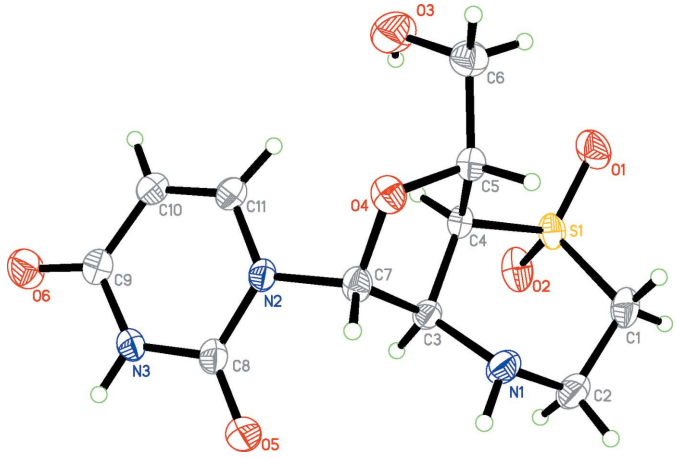


Figure 1
The molecular structure of (I) showing the atom-labelling scheme. Displacement ellipsoids are drawn at the 30% probability level. H atoms are represented by circles of arbitrary radius.

Data collection: *RAPID-AUTO* (Rigaku, 1998); cell refinement: *RAPID-AUTO*; data reduction: *CrystalStructure* (Rigaku, 2002); program(s) used to solve structure: *SHELXS97* (Sheldrick, 1997); program(s) used to refine structure: *SHELXL97* (Sheldrick, 1997); molecular graphics: *PLATON* (Spek, 2003); software used to prepare material for publication: *SHELXL97*.

We thank the National Natural Science Foundation of China (grant No. 20372025).

References

Altona, C. & Sundaralingam, M. (1972). *J. Am. Chem. Soc.* **94**, 8205–8212.
Altona, C. & Sundaralingam, M. (1973). *J. Am. Chem. Soc.* **95**, 2333–2344.
Flack, H. D. (1983). *Acta Cryst.* A**39**, 876–881.
Higashi, T. (1995). *ABSCOR*. Rigaku Corporation, Tokyo, Japan.
Len, C. & Mackenzie, G. (2006). *Tetrahedron*, **62**, 9085–9107.
Meldgaard, M. & Wengel, J. (2000). *J. Chem. Soc. Perkin Trans. 1*, pp. 3539–3554.
Rigaku (1998). *RAPID-AUTO*. Rigaku Corporation, Tokyo, Japan.
Rigaku (2002). *CrystalStructure*. Rigaku/MSC Inc., The Woodlands, Texas, USA.
Sanger, W. (1984). *Principles of Nucleic Acid Structure*, edited by C. R. Cantor. New York: Springer Verlag.
Sharma, P. K. & Nielsen, P. (2004). *J. Org. Chem.* **69**, 5742–5745.
Sheldrick, G. M. (1997). *SHELXL97* and *SHELXS97*. University of Göttingen, Germany.
Spek, A. L. (2003). *J. Appl. Cryst.* **36**, 7–13.
Vanheusden, V., Munier-Lehmann, H., Froeyen, M., Busson, R., Rozenski, J., Herdewijn, P. & Calenbergh, S. V. (2004). *J. Med. Chem.* **47**, 6187–6194.