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2,5-Anhydro-*N*-benzyl-2-*C*-methyl-D-arabinonamide [(2*S*,3*R*,4*R*)-*N*-benzyl-3,4-dihydroxy-2-methyltetrahydrofuran-2-carboxamide]

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Key indicators

Single-crystal X-ray study
T = 190 K
Mean σ(C–C) = 0.003 Å
R factor = 0.038
wR factor = 0.087
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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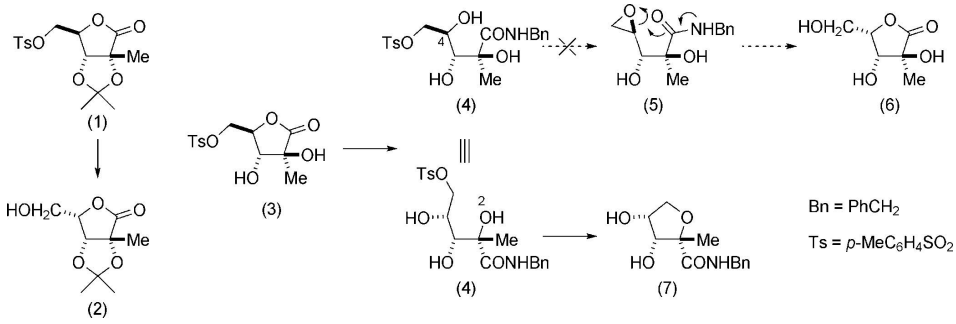
The size of the ring and relative configuration of the chiral centres in the title compound, $C_{13}H_{17}NO_4$, formed by the preferential formation of the hindered five-membered ring tetrahydrofuran rather than the expected three-membered ring epoxide, was established by X-ray crystallographic analysis; the absolute configuration was determined by the use of 2-*C*-methyl-D-*arabinono*-lactone as the starting material. The crystal structure consists of hydrogen-bonded layers lying with their hydrophobic surfaces in contact.

Comment

Carbohydrate lactones are among the most powerful chirons (Lundt & Madsen, 2001), being ideal scaffolds for the synthesis of optically pure complex natural products (Lichtenthaler & Peters, 2004; Bols, 1996). Epimerization at C4 of the lactone is usually a very efficient reaction, which effectively doubles the number of lactones that are readily available (Kold *et al.*, 1994; Frank & Lundt, 1995); the transformation can be conducted on a multikilogram scale (Batra *et al.*, 2006). Among other recent examples (Håkansson *et al.*, 2006; Van Ameijde *et al.*, 2004; Simone *et al.*, 2005), the treatment of the 2-*C*-methyl-D-ribonolactone tosylate (1) with base allows access to the L-lyxono-epimer (2) in very high yield (Hotchkiss *et al.*, 2007).



It was thus expected that treatment of the tosylate (3) of 2-*C*-methyl-D-arabinonolactone (Hotchkiss *et al.*, 2006) would give the L-xylono epimer (6); however, a complex mixture of products was obtained. Accordingly the reaction sequence treatment of (3) with benzylamine was expected to give ring opening of the lactone unit to (4) which would be followed by formation of the epoxide (5) from attack of the C4 hydroxyl group; (5) could be subsequently closed to the target (6). A product was isolated from the reaction of benzylamine with (3) in 61% yield. X-ray crystallographic analysis showed that the much hindered tertiary alcohol at C2 of (4) had closed to form the tetrahydrofuran (7). The connectivity of the C and H

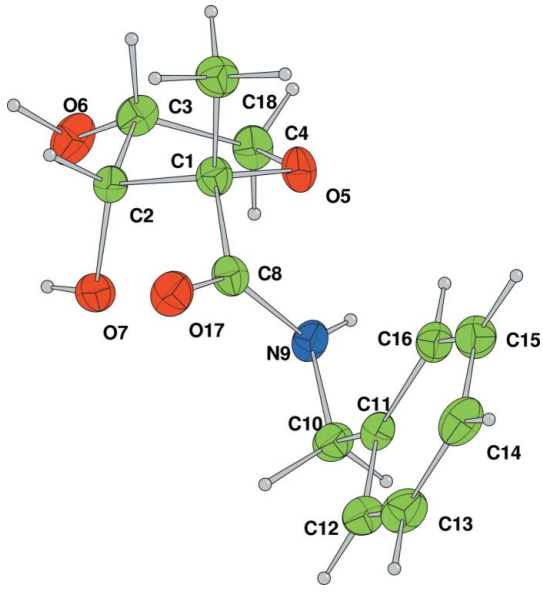


Figure 1
The molecular structure of the title compound, with displacement ellipsoids drawn at the 50% probability level. H atoms are shown as spheres of arbitary radius.

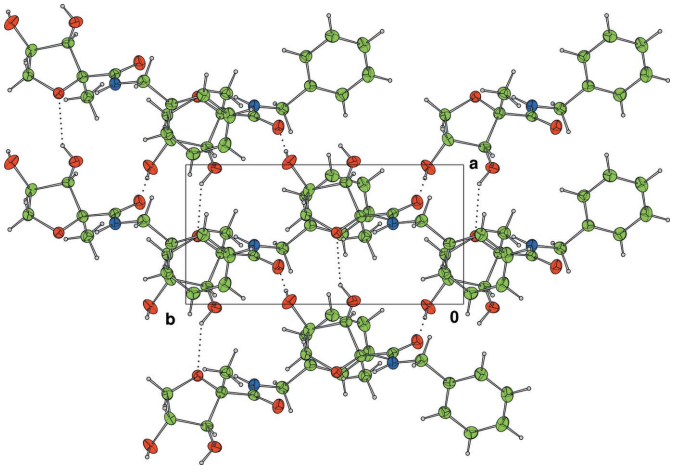


Figure 2
Partial packing diagram of the title compound showing a single hydrogen-bonded (dotted lines) layer lying perpendicular to the *c* axis. Each molecule is involved in only two hydrogen bonds.

atoms is the same in both (5) and (7), and the X-ray experiment unequivocally established that the five-membered ring THF (7) was formed in preference to the three-membered ring epoxide (5); the absolute configuration of (7) is determined by the use of 2-*C*-methyl-D-arabinonolactone as the starting material.

The molecular structure (Fig. 1) shows no abnormal features, even a short internal N—H···O contact (Table 1) having no visible influence [largest distance deviation from the *MOGUL* norms (Bruno *et al.*, 2004) is C1—O5 (1.46 *vs* 1.43 Å), largest angle deviation is C11—C16—C10 (122.8 *vs* 120.8°)]. The crystal structure consists of hydrogen-bonded sheets (Fig. 2). Both faces of the sheets are composed largely

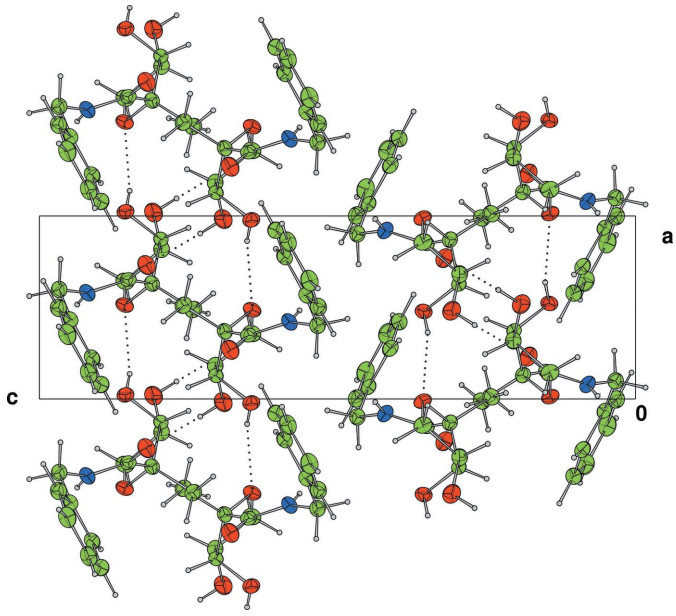


Figure 3
Partial packing diagram viewed perpendicular to the plane of the molecular sheets showing hydrophobic (largely aromatic) plane-to-plane contacts at $(x, y, \frac{1}{2})$. Hydrogen bonds are shown as dotted lines.

of phenyl groups which lie in contact in the crystal structure (Fig. 3).

Experimental

The synthesis of (3) is described in the *Comment* and shown in the scheme; full details will be reported elsewhere. The sample for analysis was crystallized from a 2:1 mixture of ethanol and methanol to yield colourless needles with m.p. 402–404 K and $[\alpha]_D^{19} = -18.5$ (c =1.00, CH_3OH).

Crystal data

$C_{13}H_{17}NO_4$
$M_r = 251.28$
Orthorhombic, $P2_12_12_1$
$a = 5.6899\ (2)$ Å
$b = 11.3507\ (4)$ Å
$c = 18.5291\ (9)$ Å
$V = 1196.69\ (8)$ Å^3
$Z = 4$
$D_x = 1.395$ Mg m^{-3}
Mo $K\alpha$ radiation
$\mu = 0.10$ mm^{-1}
$T = 190$ K
Needle, colourless
0.40 × 0.06 × 0.06 mm

Data collection

Nonius KappaCCD diffractometer
ω scans
Absorption correction: multi-scan (*DENZO*/*SCALEPACK*; Otwinowski & Minor, 1997)
$T_{min} = 0.96$, $T_{max} = 0.99$
5880 measured reflections
1575 independent reflections
1249 reflections with $I > 2\sigma(I)$
$R_{int} = 0.049$
$\theta_{max} = 27.5°$

Refinement

Refinement on F^2
$R[F^2 > 2\sigma(F^2)] = 0.038$
$wR(F^2) = 0.087$
$S = 0.93$
1575 reflections
163 parameters
H-atom parameters constrained
$w = 1/[\sigma^2(F^2) + (0.03P)^2 + 0.15P]$, where $P = [\max(F_o^2,0) + 2F_c^2]/3$
$(\Delta/\sigma)_{max} < 0.001$
$\Delta\rho_{max} = 0.26$ e Å^{-3}
$\Delta\rho_{min} = -0.29$ e Å^{-3}

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

D—H···A	D—H	H···A	D···A	D—H···A
N9—H1···O5	0.88	2.15	2.606 (2)	112
O7—H15···O5^{i}	0.86	2.15	2.878 (2)	142
O6—H19···O17^{ii}	0.85	1.96	2.816 (2)	179

Symmetry codes: (i) $x-1, y, z$; (ii) $-x, y+\frac{1}{2}, -z+\frac{3}{2}$.

In the absence of significant anomalous scattering, Friedel pairs were merged and the absolute configuration assigned on the basis of the starting material.

The H atoms were all located in a difference map, but those attached to C atoms were repositioned geometrically. The H atoms were initially refined with soft restraints on the bond lengths and angles to regularize their geometry (C—H in the range 0.93–0.98, N—H to 0.86, O—H = 0.82 Å) and U_{iso}(H) (in the range 1.2–1.5 times U_{eq} of the parent atom), after which the positions were refined with riding constraints.

Data collection: *COLLECT* (Nonius, 2001); 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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