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4-Chloro-*N*-(isoquinolin-3-yl)butanamide

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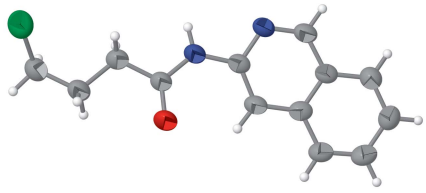
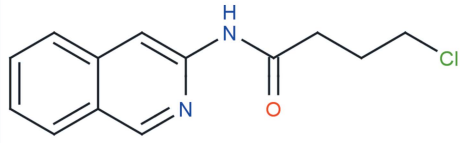
Structural data: full structural data are available from iucrdata.iucr.org

All C, N and O atoms of the title compound, $C_{13}H_{13}ClN_2O$, lie in a common plane (r.m.s. deviation = 0.096 Å). The Cl atom deviates by 0.940 (3) Å from this plane. In the crystal, molecules are linked *via* N—H···N and C—H···O hydrogen bonds which form $R_2^2(8)$ and $R_2^2(16)$ graph-set dimers. In addition, molecules are linked *via* C—H···O intermolecular interactions which form $C(4)$ chains propagating along the [100] direction of the unit cell.

3D view



Chemical scheme



Structure description

Isoquinoline derivatives act as potential phosphodiesterase type 4 (PDE4) and histone deacetylase inhibitors (Song *et al.*, 2015; Yang *et al.*, 2015*a*). These derivatives act as anticancer agents (Yang *et al.*, 2015*b*). In view of the interesting applications of isoquinoline derivatives, we synthesized the title compound and report herein its crystal structure. The molecular structure of the title compound is illustrated in Fig. 1.

All C, N and O atoms lie in a common plane (r.m.s. deviation = 0.096 Å). The Cl atom deviates by 0.940 (3) Å from this plane.

The molecular structure is influenced by intramolecular C—H···O interactions (Table 1). In the crystal, N—H···N and C—H···O intermolecular hydrogen bonds link the molecules, forming $R_2^2(8)$ and $R_2^2(16)$ graph-set dimers in the unit cell (Fig. 2). In addition, C—H···O intermolecular interactions link the molecules, forming $C(4)$ chains propagating along the [100] plane of the unit cell (Fig. 3).

Synthesis and crystallization

To a stirred solution of 3-aminoisoquinoline (1 g, 1 equivalent) in dichloromethane (10 ml), 1.5 equivalents of pyridine (0.82 g) were added and allowed to stir for 20 min.

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

D—H···A	D—H	H···A	D···A	D—H···A
C8—H8···O1	0.93	2.27	2.863 (4)	121
N2—H2···N1^{i}	0.86	2.50	3.348 (4)	169
C6—H6···O1^{ii}	0.93	2.58	3.475 (4)	161
C11—H11A···O1^{iii}	0.97	2.56	3.503 (4)	163

Symmetry codes: (i) $-x, -y, -z$; (ii) $-x+1, -y+1, -z$; (iii) $x-1, y, z$.

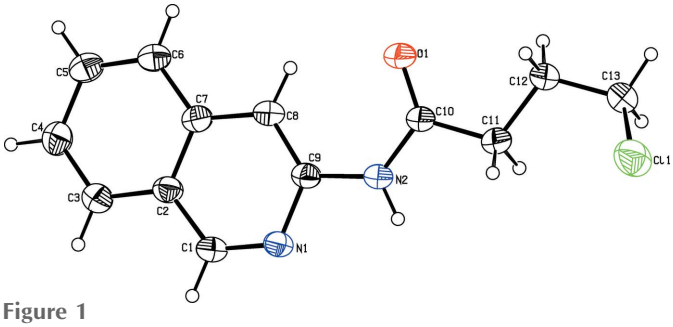


Figure 1
The molecular structure of the title compound, showing the atom labelling. Displacement ellipsoids are drawn at the 30% probability level.

The reaction mixture was cooled to 273 K. Then, 1.1 equivalents of chlorobutyryl chloride (1.07 g) were added dropwise to the reaction mass over a period of 5 min. The reaction mass was warmed to room temperature and stirring was continued for 90 min. Upon completion of the reaction, the reaction mass was quenched with water and extracted with dichloromethane. The organic layer was further washed with 10% sodium bicarbonate solution (10 ml), and 1 N HCl (10 ml) was added to the organic layer, which was dried over sodium sulfate and concentrated under reduced pressure. The crude product was triturated with dichloromethane–hexane to yield 1.2 g (69.7%) of the pure product of the title compound. The solid was further recrystallized from ethanol to yield a diffraction-quality crystal of the title compound.

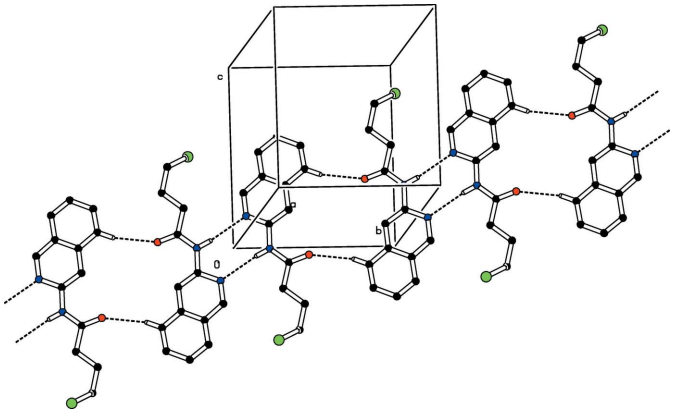


Figure 2
The crystal packing of the title compound, viewed down the *a* axis. N—H···N and C—H···O hydrogen bonds are shown as dashed lines (see Table 1). For clarity, H atoms not involved in these hydrogen bonds have been omitted.

Table 2
Experimental details.

Crystal data	
Chemical formula	$C_{13}H_{13}ClN_2O$
M_r	248.70
Crystal system, space group	Triclinic, $P\overline{1}$
Temperature (K)	293
a, b, c (Å)	5.263 (3), 9.782 (5), 12.795 (6)
α, β, γ (°)	78.591 (9), 80.188 (7), 74.418 (10)
V (Å^3)	617.2 (5)
Z	2
Radiation type	Mo $K\alpha$
μ (mm^{-1})	0.29
Crystal size (mm)	0.40 × 0.20 × 0.20
Data collection	
Diffractometer	Rigaku Saturn724+ area-dectector
No. of measured, independent and observed [$I > 2\sigma(I)$] reflections	3534, 2746, 1546
R_{int}	0.124
$(\sin \theta/\lambda)_{max}$ (Å^{-1})	0.653
Refinement	
$R[F^2 > 2\sigma(F^2)]$, $wR(F^2)$, S	0.069, 0.227, 1.01
No. of reflections	2746
No. of parameters	154
H-atom treatment	H-atom parameters constrained
$\Delta\rho_{max}$, $\Delta\rho_{min}$ (e Å^{-3})	0.20, −0.51

Computer programs: *CrystalClear SM-Expert* (Rigaku, 2011), *SHELXS97* (Sheldrick, 2008), *ORTEP-3 for Windows* (Farrugia, 2012), *SHELXL2014* (Sheldrick, 2015) and *PLATON* (Spek, 2009).

Refinement

Crystal data, data collection and structure refinement details are summarized in Table 2.

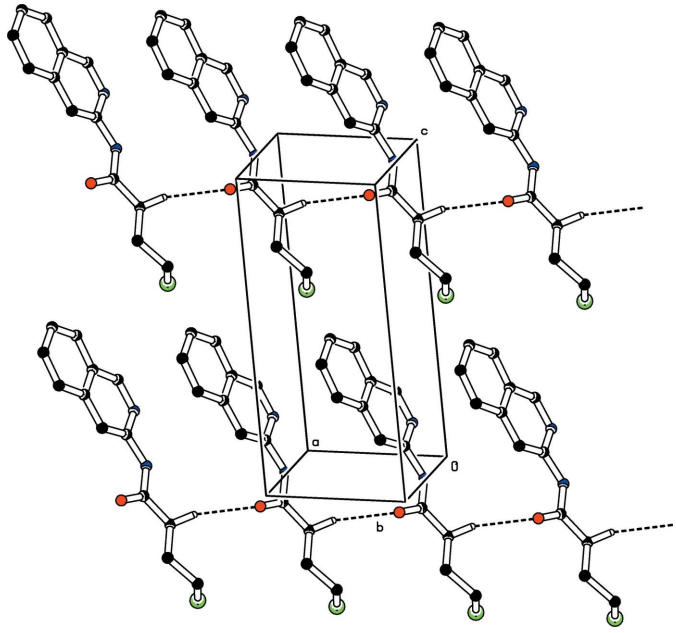


Figure 3
The packing of the title compound, showing C—H···O interactions as dashed lines forming *C*(4) chain. For clarity, H atoms not involved in these interactions have been omitted.

References

Farrugia, L. J. (2012). *J. Appl. Cryst.* **45**, 849–854.
Rigaku (2011). *CrystalClear SM-Expert*. Rigaku Corporation, Tokyo, Japan.
Sheldrick, G. M. (2008). *Acta Cryst.* A**64**, 112–122.
Sheldrick, G. M. (2015). *Acta Cryst.* C**71**, 3–8.
Song, G., Zhao, D., Hu, D., Li, Y., Jin, H. & Cui, Z. (2015). *Bioorg. Med. Chem. Lett.* **25**, 4610–4614.
Spek, A. L. (2009). *Acta Cryst.* D**65**, 148–155.
Yang, W., Li, L., Wang, Y., Wu, X., Li, T., Yang, N., Su, M., Sheng, L., Zheng, M., Zang, Y., Li, J. & Liu, H. (2015*a*). *Bioorg. Med. Chem.* **23**, 5881–5890.
Yang, X., Yang, S., Chai, H., Yang, Z., Lee, R. J., Liao, W. & Teng, L. (2015*b*). *PLoS One*, **10**, e0136649.

full crystallographic data

IUCrData (2016). **1**, x161290 [doi:10.1107/S2414314616012906]

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Crystal data

$C_{13}H_{13}ClN_2O$
$M_r = 248.70$
Triclinic, $P\overline{1}$
$a = 5.263$ (3) Å
$b = 9.782$ (5) Å
$c = 12.795$ (6) Å
$\alpha = 78.591$ (9)°
$\beta = 80.188$ (7)°
$\gamma = 74.418$ (10)°
$V = 617.2$ (5) Å^3
$Z = 2$
$F(000) = 260$
$D_x = 1.338$ Mg m^{-3}
Mo $K\alpha$ radiation, $\lambda = 0.71073$ Å
Cell parameters from 2288 reflections
$\theta = 3.2$–26.8°
$\mu = 0.29$ mm^{-1}
$T = 293$ K
Prism, colourless
0.40 × 0.20 × 0.20 mm

Data collection

Rigaku Saturn724+ area-dectector diffractometer
Radiation source: fine-focus sealed tube
ω scans
3534 measured reflections
2746 independent reflections
1546 reflections with $I > 2\sigma(I)$
$R_{int} = 0.124$
$\theta_{max} = 27.7°$, $\theta_{min} = 3.3°$
$h = -6\rightarrow6$
$k = -12\rightarrow8$
$l = -16\rightarrow11$

Refinement

Refinement on F^2
Least-squares matrix: full
$R[F^2 > 2\sigma(F^2)] = 0.069$
$wR(F^2) = 0.227$
$S = 1.01$
2746 reflections
154 parameters
0 restraints
Hydrogen site location: inferred from neighbouring sites
H-atom parameters constrained
$w = 1/[\sigma^2(F_o^2) + (0.1016P)^2]$ where $P = (F_o^2 + 2F_c^2)/3$
$(\Delta/\sigma)_{max} < 0.001$
$\Delta\rho_{max} = 0.20$ e Å^{-3}
$\Delta\rho_{min} = -0.51$ e Å^{-3}

Special details

Geometry. All esds (except the esd in the dihedral angle between two l.s. planes) are estimated using the full covariance matrix. The cell esds are taken into account individually in the estimation of esds in distances, angles and torsion angles; correlations between esds in cell parameters are only used when they are defined by crystal symmetry. An approximate (isotropic) treatment of cell esds is used for estimating esds involving l.s. planes.

Fractional atomic coordinates and isotropic or equivalent isotropic displacement parameters (Å²)

	x	*y*	*z*	U_{iso}*/U_{eq}
Cl1	−0.2114 (2)	0.32757 (11)	−0.44065 (7)	0.0864 (4)

O1	0.2508 (5)	0.3932 (2)	−0.12457 (19)	0.0706 (7)
N1	0.2207 (5)	0.0212 (3)	0.10506 (19)	0.0479 (6)
N2	0.1134 (5)	0.1921 (3)	−0.04217 (18)	0.0504 (6)
H2	0.0160	0.1372	−0.0488	0.060*
C1	0.3335 (6)	−0.0247 (3)	0.1944 (3)	0.0544 (8)
H1	0.3133	−0.1125	0.2340	0.065*
C2	0.4829 (6)	0.0498 (3)	0.2343 (2)	0.0490 (7)
C3	0.5944 (7)	−0.0020 (4)	0.3322 (3)	0.0592 (8)
H3	0.5702	−0.0884	0.3731	0.071*
C4	0.7372 (7)	0.0742 (4)	0.3668 (3)	0.0668 (9)
H4	0.8106	0.0394	0.4309	0.080*
C5	0.7737 (7)	0.2064 (4)	0.3051 (3)	0.0617 (9)
H5	0.8722	0.2573	0.3291	0.074*
C6	0.6667 (6)	0.2599 (3)	0.2112 (3)	0.0554 (8)
H6	0.6923	0.3468	0.1717	0.066*
C7	0.5160 (6)	0.1831 (3)	0.1737 (2)	0.0477 (7)
C8	0.3925 (6)	0.2331 (3)	0.0787 (2)	0.0497 (7)
H8	0.4076	0.3205	0.0369	0.060*
C9	0.2501 (5)	0.1512 (3)	0.0488 (2)	0.0446 (7)
C10	0.1164 (6)	0.3077 (3)	−0.1209 (2)	0.0485 (7)
C11	−0.0623 (6)	0.3197 (3)	−0.2049 (2)	0.0557 (8)
H11A	−0.2423	0.3243	−0.1698	0.067*
H11B	−0.0044	0.2336	−0.2381	0.067*
C12	−0.0639 (6)	0.4503 (3)	−0.2919 (3)	0.0585 (8)
H12A	−0.0974	0.5352	−0.2583	0.070*
H12B	0.1103	0.4391	−0.3338	0.070*
C13	−0.2694 (7)	0.4728 (4)	−0.3661 (3)	0.0643 (9)
H13A	−0.2698	0.5615	−0.4161	0.077*
H13B	−0.4435	0.4831	−0.3243	0.077*

Atomic displacement parameters (Å²)

	U^{11}	U^{22}	U^{33}	U^{12}	U^{13}	U^{23}
Cl1	0.1257 (10)	0.0752 (7)	0.0648 (6)	−0.0301 (6)	−0.0284 (6)	−0.0042 (5)
O1	0.0827 (17)	0.0644 (15)	0.0754 (15)	−0.0452 (13)	−0.0274 (13)	0.0170 (12)
N1	0.0511 (14)	0.0387 (13)	0.0539 (14)	−0.0145 (11)	−0.0064 (11)	−0.0026 (10)
N2	0.0528 (15)	0.0450 (14)	0.0557 (14)	−0.0218 (11)	−0.0103 (11)	0.0032 (11)
C1	0.0579 (19)	0.0437 (17)	0.0635 (19)	−0.0212 (14)	−0.0089 (15)	0.0002 (13)
C2	0.0531 (18)	0.0396 (16)	0.0554 (17)	−0.0136 (13)	−0.0060 (13)	−0.0079 (12)
C3	0.066 (2)	0.0543 (19)	0.0581 (19)	−0.0200 (16)	−0.0130 (15)	0.0008 (14)
C4	0.077 (2)	0.067 (2)	0.063 (2)	−0.0202 (18)	−0.0255 (17)	−0.0069 (17)
C5	0.068 (2)	0.057 (2)	0.068 (2)	−0.0229 (17)	−0.0087 (16)	−0.0199 (16)
C6	0.062 (2)	0.0465 (17)	0.0624 (19)	−0.0196 (15)	−0.0059 (15)	−0.0126 (14)
C7	0.0435 (16)	0.0436 (16)	0.0571 (17)	−0.0128 (13)	−0.0006 (13)	−0.0120 (13)
C8	0.0557 (18)	0.0409 (16)	0.0548 (17)	−0.0193 (14)	−0.0040 (13)	−0.0053 (12)
C9	0.0443 (16)	0.0397 (15)	0.0485 (15)	−0.0135 (12)	0.0003 (12)	−0.0047 (11)
C10	0.0511 (17)	0.0450 (16)	0.0516 (16)	−0.0205 (13)	−0.0084 (12)	0.0007 (12)
C11	0.0577 (19)	0.0545 (18)	0.0604 (18)	−0.0265 (15)	−0.0130 (14)	0.0011 (14)

C12	0.058 (2)	0.0500 (18)	0.068 (2)	−0.0219 (15)	−0.0162 (15)	0.0065 (14)
C13	0.069 (2)	0.0540 (19)	0.070 (2)	−0.0187 (17)	−0.0199 (17)	0.0055 (15)

Geometric parameters (Å, º)

Cl1—C13	1.796 (4)	C5—H5	0.9300
O1—C10	1.222 (3)	C6—C7	1.420 (4)
N1—C1	1.321 (4)	C6—H6	0.9300
N1—C9	1.366 (3)	C7—C8	1.415 (4)
N2—C10	1.359 (3)	C8—C9	1.375 (4)
N2—C9	1.407 (4)	C8—H8	0.9300
N2—H2	0.8600	C10—C11	1.513 (4)
C1—C2	1.415 (4)	C11—C12	1.520 (4)
C1—H1	0.9300	C11—H11A	0.9700
C2—C7	1.417 (4)	C11—H11B	0.9700
C2—C3	1.418 (4)	C12—C13	1.503 (4)
C3—C4	1.364 (4)	C12—H12A	0.9700
C3—H3	0.9300	C12—H12B	0.9700
C4—C5	1.418 (5)	C13—H13A	0.9700
C4—H4	0.9300	C13—H13B	0.9700
C5—C6	1.363 (5)		
C1—N1—C9	116.6 (2)	C9—C8—H8	120.3
C10—N2—C9	128.0 (2)	C7—C8—H8	120.3
C10—N2—H2	116.0	N1—C9—C8	124.0 (3)
C9—N2—H2	116.0	N1—C9—N2	111.8 (2)
N1—C1—C2	124.9 (3)	C8—C9—N2	124.2 (3)
N1—C1—H1	117.5	O1—C10—N2	123.8 (3)
C2—C1—H1	117.5	O1—C10—C11	123.0 (2)
C1—C2—C7	117.7 (3)	N2—C10—C11	113.2 (2)
C1—C2—C3	122.9 (3)	C10—C11—C12	113.4 (2)
C7—C2—C3	119.5 (3)	C10—C11—H11A	108.9
C4—C3—C2	120.4 (3)	C12—C11—H11A	108.9
C4—C3—H3	119.8	C10—C11—H11B	108.9
C2—C3—H3	119.8	C12—C11—H11B	108.9
C3—C4—C5	120.1 (3)	H11A—C11—H11B	107.7
C3—C4—H4	120.0	C13—C12—C11	113.1 (3)
C5—C4—H4	120.0	C13—C12—H12A	109.0
C6—C5—C4	121.0 (3)	C11—C12—H12A	109.0
C6—C5—H5	119.5	C13—C12—H12B	109.0
C4—C5—H5	119.5	C11—C12—H12B	109.0
C5—C6—C7	120.1 (3)	H12A—C12—H12B	107.8
C5—C6—H6	120.0	C12—C13—Cl1	112.8 (2)
C7—C6—H6	120.0	C12—C13—H13A	109.0
C8—C7—C2	117.4 (3)	Cl1—C13—H13A	109.0
C8—C7—C6	123.6 (3)	C12—C13—H13B	109.0
C2—C7—C6	119.0 (3)	Cl1—C13—H13B	109.0
C9—C8—C7	119.4 (3)	H13A—C13—H13B	107.8

C9—N1—C1—C2	−0.8 (5)	C2—C7—C8—C9	−0.7 (4)
N1—C1—C2—C7	−0.5 (5)	C6—C7—C8—C9	−179.9 (3)
N1—C1—C2—C3	178.3 (3)	C1—N1—C9—C8	1.4 (4)
C1—C2—C3—C4	179.9 (3)	C1—N1—C9—N2	−177.6 (2)
C7—C2—C3—C4	−1.3 (5)	C7—C8—C9—N1	−0.7 (4)
C2—C3—C4—C5	0.3 (5)	C7—C8—C9—N2	178.2 (2)
C3—C4—C5—C6	0.4 (6)	C10—N2—C9—N1	−174.0 (3)
C4—C5—C6—C7	−0.1 (5)	C10—N2—C9—C8	7.0 (5)
C1—C2—C7—C8	1.2 (4)	C9—N2—C10—O1	2.2 (5)
C3—C2—C7—C8	−177.6 (3)	C9—N2—C10—C11	−178.3 (3)
C1—C2—C7—C6	−179.5 (3)	O1—C10—C11—C12	−1.7 (5)
C3—C2—C7—C6	1.6 (4)	N2—C10—C11—C12	178.9 (3)
C5—C6—C7—C8	178.2 (3)	C10—C11—C12—C13	−172.0 (3)
C5—C6—C7—C2	−1.0 (5)	C11—C12—C13—Cl1	−63.1 (4)

Hydrogen-bond geometry (Å, º)

D—H···*A*	*D*—H	H···*A*	*D*···*A*	*D*—H···*A*
C8—H8···O1	0.93	2.27	2.863 (4)	121
N2—H2···N1^{i}	0.86	2.50	3.348 (4)	169
C6—H6···O1^{ii}	0.93	2.58	3.475 (4)	161
C11—H11*A*···O1^{iii}	0.97	2.56	3.503 (4)	163

Symmetry codes: (i) −*x*, −*y*, −*z*; (ii) −*x*+1, −*y*+1, −*z*; (iii) *x*−1, *y*, *z*.