



wwPDB X-ray Structure Validation Summary Report ⓘ

Mar 10, 2026 – 08:28 AM UTC

PDB ID : 8D29 / pdb_00008d29
Title : Crystal structure of theophylline aptamer - apo form
Authors : Menichelli, E.; Spraggon, G.
Deposited on : 2022-05-28
Resolution : 1.81 Å(reported)

This is a wwPDB X-ray Structure Validation Summary Report for a publicly released PDB entry.

We welcome your comments at validation@mail.wwpdb.org

A user guide is available at

<https://www.wwpdb.org/validation/2017/XrayValidationReportHelp>

with specific help available everywhere you see the ⓘ symbol.

The types of validation reports are described at

<http://www.wwpdb.org/validation/2017/FAQs#types>.

The following versions of software and data (see [references ⓘ](#)) were used in the production of this report:

MolProbity : 4-5-2 with Phenix2.0
Xtriage (Phenix) : 2.0
EDS : 3.0
Percentile statistics : 20250101.v01 (using entries in the PDB archive January 1st 2025)
CCP4 : 9.0.010 (Gargrove)
Density-Fitness : 1.0.12
Ideal geometry (proteins) : Engh & Huber (2001)
Ideal geometry (DNA, RNA) : Parkinson et al. (1996)
Validation Pipeline (wwPDB-VP) : 2.49

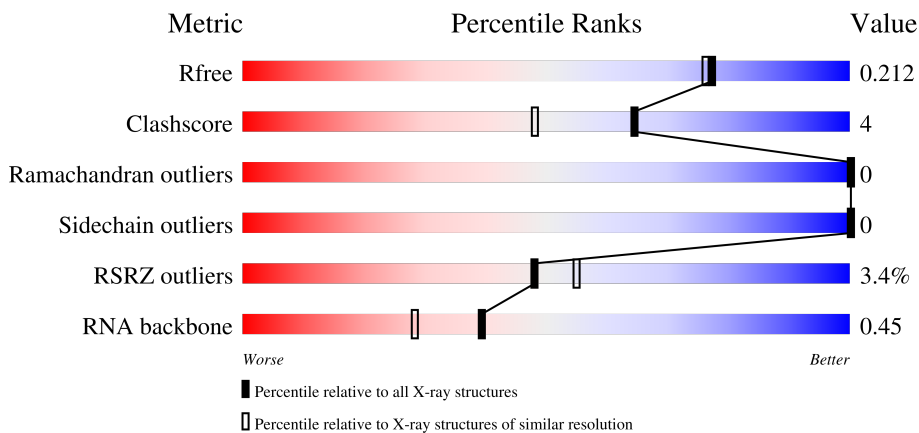
1 Overall quality at a glance

The following experimental techniques were used to determine the structure:

X-RAY DIFFRACTION

The reported resolution of this entry is 1.81 Å.

Percentile scores (ranging between 0-100) for global validation metrics of the entry are shown in the following graphic. The table shows the number of entries on which the scores are based.



Metric	Whole archive (#Entries)	Similar resolution (#Entries, resolution range(Å))
R_{free}	180053	1112 (1.82-1.82)
Clashscore	190562	1148 (1.82-1.82)
Ramachandran outliers	187476	1140 (1.82-1.82)
Sidechain outliers	187428	1140 (1.82-1.82)
RSRZ outliers	180081	1112 (1.82-1.82)
RNA backbone	3983	1006 (2.22-1.42)

The table below summarises the geometric issues observed across the polymeric chains and their fit to the electron density. The red, orange, yellow and green segments of the lower bar indicate the fraction of residues that contain outliers for ≥ 3 , 2, 1 and 0 types of geometric quality criteria respectively. A grey segment represents the fraction of residues that are not modelled. The numeric value for each fraction is indicated below the corresponding segment, with a dot representing fractions $\leq 5\%$. The upper red bar (where present) indicates the fraction of residues that have poor fit to the electron density. The numeric value is given above the bar.

Mol	Chain	Length	Quality of chain
1	A	229	 91% 6%
1	D	229	 93%
1	G	229	 92% 5%
1	H	229	 91% 5%

Continued on next page...

Continued from previous page...

Mol	Chain	Length	Quality of chain
2	B	214	<p>% 84% 14%</p>
2	E	214	<p>% 88% 11%</p>
2	I	214	<p>% 89% 11%</p>
2	L	214	<p>% 90% 10%</p>
3	C	34	<p>12% 62% 38%</p>
3	F	34	<p>24% 65% 32%</p>
3	J	34	<p>41% 47% 50%</p>
3	R	34	<p>47% 65% 12% 24%</p>

2 Entry composition [i](#)

There are 6 unique types of molecules in this entry. The entry contains 18122 atoms, of which 0 are hydrogens and 0 are deuteriums.

In the tables below, the ZeroOcc column contains the number of atoms modelled with zero occupancy, the AltConf column contains the number of residues with at least one atom in alternate conformation and the Trace column contains the number of residues modelled with at most 2 atoms.

- Molecule 1 is a protein called Fab heavy chain.

Mol	Chain	Residues	Atoms					ZeroOcc	AltConf	Trace
			Total	C	N	O	S			
1	A	223	Total 1669	C 1052	N 285	O 326	S 6	0	2	0
1	D	224	Total 1675	C 1054	N 285	O 330	S 6	0	2	0
1	G	218	Total 1630	C 1029	N 275	O 319	S 7	0	2	0
1	H	220	Total 1656	C 1045	N 283	O 322	S 6	0	3	0

- Molecule 2 is a protein called Fab light chain.

Mol	Chain	Residues	Atoms					ZeroOcc	AltConf	Trace
			Total	C	N	O	S			
2	B	213	Total 1635	C 1022	N 274	O 332	S 7	2	2	0
2	E	213	Total 1635	C 1021	N 273	O 334	S 7	2	2	0
2	I	213	Total 1636	C 1022	N 274	O 334	S 6	2	1	0
2	L	214	Total 1645	C 1027	N 275	O 335	S 8	2	2	0

- Molecule 3 is a RNA chain called RNA (34-MER).

Mol	Chain	Residues	Atoms					ZeroOcc	AltConf	Trace
			Total	C	N	O	P			
3	C	34	Total 723	C 324	N 134	O 232	P 33	0	0	0
3	F	34	Total 723	C 324	N 134	O 232	P 33	60	0	0
3	J	34	Total 723	C 324	N 134	O 232	P 33	60	0	0
3	R	34	Total 723	C 324	N 134	O 232	P 33	0	0	0

- Molecule 4 is POTASSIUM ION (CCD ID: K) (formula: K).

Mol	Chain	Residues	Atoms	ZeroOcc	AltConf
4	A	2	Total K 2 2	0	0
4	D	1	Total K 1 1	0	0
4	E	1	Total K 1 1	0	0
4	H	1	Total K 1 1	0	0

- Molecule 5 is SODIUM ION (CCD ID: NA) (formula: Na).

Mol	Chain	Residues	Atoms	ZeroOcc	AltConf
5	G	1	Total Na 1 1	0	0

- Molecule 6 is water.

Mol	Chain	Residues	Atoms	ZeroOcc	AltConf
6	A	299	Total O 299 299	0	0
6	B	208	Total O 208 208	0	0
6	C	42	Total O 42 42	0	0
6	D	313	Total O 313 313	0	0
6	E	208	Total O 208 208	0	0
6	F	27	Total O 27 27	0	0
6	G	267	Total O 267 267	0	0
6	H	266	Total O 266 266	0	0
6	I	180	Total O 180 180	0	0
6	J	17	Total O 17 17	0	0
6	L	197	Total O 197 197	0	0
6	R	19	Total O 19 19	0	0

3 Residue-property plots [i](#)

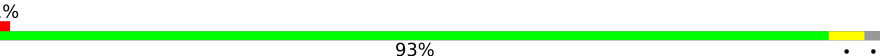
These plots are drawn for all protein, RNA, DNA and oligosaccharide chains in the entry. The first graphic for a chain summarises the proportions of the various outlier classes displayed in the second graphic. The second graphic shows the sequence view annotated by issues in geometry and electron density. Residues are color-coded according to the number of geometric quality criteria for which they contain at least one outlier: green = 0, yellow = 1, orange = 2 and red = 3 or more. A red dot above a residue indicates a poor fit to the electron density ($RSRZ > 2$). Stretches of 2 or more consecutive residues without any outlier are shown as a green connector. Residues present in the sample, but not in the model, are shown in grey.

- Molecule 1: Fab heavy chain

Chain A:  91% 6%

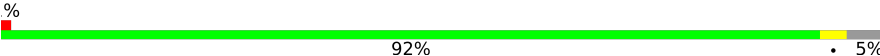


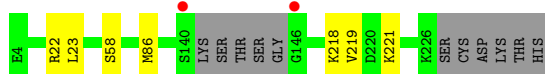
- Molecule 1: Fab heavy chain

Chain D:  93%




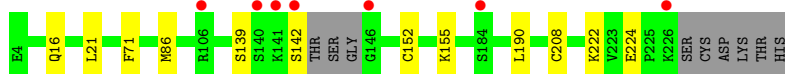
- Molecule 1: Fab heavy chain

Chain G:  92% 5%




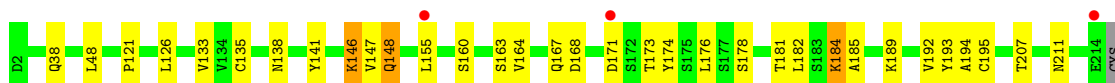
- Molecule 1: Fab heavy chain

Chain H:  91% 5%

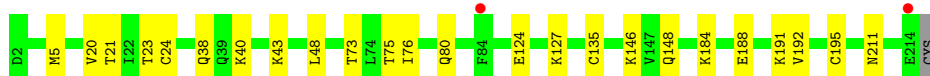
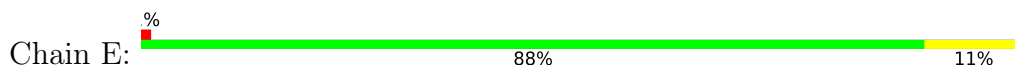


- Molecule 2: Fab light chain

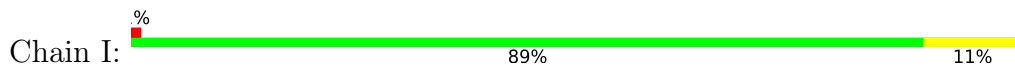
Chain B:  84% 14%



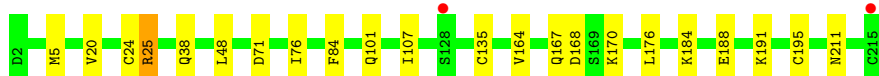
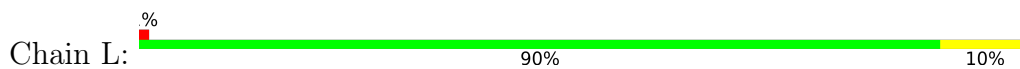
- Molecule 2: Fab light chain



- Molecule 2: Fab light chain



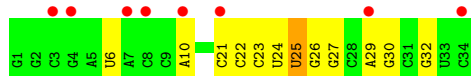
- Molecule 2: Fab light chain



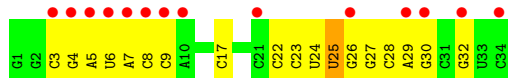
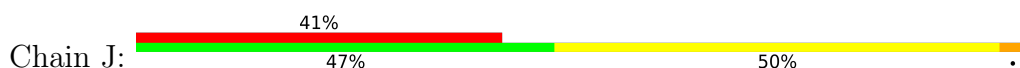
- Molecule 3: RNA (34-MER)



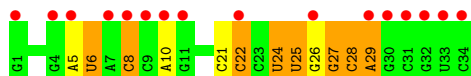
- Molecule 3: RNA (34-MER)



- Molecule 3: RNA (34-MER)



- Molecule 3: RNA (34-MER)



4 Data and refinement statistics i

Property	Value	Source
Space group	P 1	Depositor
Cell constants a, b, c, α , β , γ	76.15Å 92.85Å 93.64Å 97.34° 90.32° 106.92°	Depositor
Resolution (Å)	68.66 – 1.81 68.66 – 1.81	Depositor EDS
% Data completeness (in resolution range)	93.7 (68.66-1.81) 93.7 (68.66-1.81)	Depositor EDS
R_{merge}	0.13	Depositor
R_{sym}	(Not available)	Depositor
$\langle I/\sigma(I) \rangle$ ¹	2.92 (at 1.81Å)	Xtrriage
Refinement program	PHENIX 1.20.1_4487	Depositor
R, R_{free}	0.175 , 0.211 0.176 , 0.212	Depositor DCC
R_{free} test set	10352 reflections (4.64%)	wwPDB-VP
Wilson B-factor (Å ²)	17.9	Xtrriage
Anisotropy	0.443	Xtrriage
Bulk solvent k_{sol} (e/Å ³), B_{sol} (Å ²)	0.35 , 52.0	EDS
L-test for twinning ²	$\langle L \rangle = 0.50$, $\langle L^2 \rangle = 0.33$	Xtrriage
Estimated twinning fraction	No twinning to report.	Xtrriage
F_o, F_c correlation	0.96	EDS
Total number of atoms	18122	wwPDB-VP
Average B, all atoms (Å ²)	37.0	wwPDB-VP

Xtrriage's analysis on translational NCS is as follows: *The analyses of the Patterson function reveals a significant off-origin peak that is 30.18 % of the origin peak, indicating pseudo-translational symmetry. The chance of finding a peak of this or larger height randomly in a structure without pseudo-translational symmetry is equal to 1.3671e-03. The detected translational NCS is most likely also responsible for the elevated intensity ratio.*

¹Intensities estimated from amplitudes.

²Theoretical values of $\langle |L| \rangle$, $\langle L^2 \rangle$ for acentric reflections are 0.5, 0.333 respectively for untwinned datasets, and 0.375, 0.2 for perfectly twinned datasets.

5 Model quality [i](#)

5.1 Standard geometry [i](#)

Bond lengths and bond angles in the following residue types are not validated in this section: NA, K

The Z score for a bond length (or angle) is the number of standard deviations the observed value is removed from the expected value. A bond length (or angle) with $|Z| > 5$ is considered an outlier worth inspection. RMSZ is the root-mean-square of all Z scores of the bond lengths (or angles).

Mol	Chain	Bond lengths		Bond angles	
		RMSZ	# Z >5	RMSZ	# Z >5
1	A	0.45	1/1716 (0.1%)	0.57	0/2336
1	D	0.40	0/1722	0.58	0/2345
1	G	0.52	2/1676 (0.1%)	0.58	0/2283
1	H	0.34	0/1705	0.53	0/2319
2	B	1.13	18/1676 (1.1%)	0.74	1/2275 (0.0%)
2	E	0.34	0/1676	0.54	0/2276
2	I	0.35	0/1674	0.57	2/2272 (0.1%)
2	L	0.39	1/1686 (0.1%)	0.54	0/2288
3	C	0.18	0/808	0.34	0/1258
3	F	0.22	0/808	0.45	2/1258 (0.2%)
3	J	0.23	0/808	0.44	0/1258
3	R	0.19	0/808	0.40	0/1258
All	All	0.50	22/16763 (0.1%)	0.55	5/23426 (0.0%)

The worst 5 of 22 bond length outliers are listed below:

Mol	Chain	Res	Type	Atoms	Z	Observed(Å)	Ideal(Å)
2	B	195[A]	CYS	CA-C	8.41	1.62	1.52
2	B	195[B]	CYS	CA-C	8.41	1.62	1.52
2	B	185	ALA	C-O	-6.72	1.16	1.24
1	G	221	LYS	C-O	-6.62	1.16	1.24
2	B	163	SER	C-O	-6.51	1.16	1.23

All (5) bond angle outliers are listed below:

Mol	Chain	Res	Type	Atoms	Z	Observed(°)	Ideal(°)
3	F	25	U	C2'-C3'-O3'	6.68	123.73	113.70
3	F	25	U	C3'-C2'-O2'	5.67	119.21	110.70
2	B	138	ASN	N-CA-C	5.63	118.14	109.07
2	I	190	HIS	CA-C-N	5.01	128.67	121.71
2	I	190	HIS	C-N-CA	5.01	128.67	121.71

There are no chirality outliers.

There are no planarity outliers.

5.2 Too-close contacts

In the following table, the Non-H and H(model) columns list the number of non-hydrogen atoms and hydrogen atoms in the chain respectively. The H(added) column lists the number of hydrogen atoms added and optimized by MolProbity. The Clashes column lists the number of clashes within the asymmetric unit, whereas Symm-Clashes lists symmetry-related clashes.

Mol	Chain	Non-H	H(model)	H(added)	Clashes	Symm-Clashes
1	A	1669	0	1634	7	0
1	D	1675	0	1631	8	0
1	G	1630	0	1581	4	0
1	H	1656	0	1623	9	0
2	B	1635	0	1589	20	0
2	E	1635	0	1581	17	0
2	I	1636	0	1588	16	0
2	L	1645	0	1600	14	0
3	C	723	0	372	2	0
3	F	723	0	372	1	0
3	J	723	0	372	10	0
3	R	723	0	372	9	0
4	A	2	0	0	0	0
4	D	1	0	0	0	0
4	E	1	0	0	0	0
4	H	1	0	0	0	0
5	G	1	0	0	0	0
6	A	299	0	0	0	0
6	B	208	0	0	1	0
6	C	42	0	0	0	0
6	D	313	0	0	2	0
6	E	208	0	0	4	0
6	F	27	0	0	0	0
6	G	267	0	0	2	0
6	H	266	0	0	0	0
6	I	180	0	0	2	0
6	J	17	0	0	0	0
6	L	197	0	0	2	0
6	R	19	0	0	0	0
All	All	18122	0	14315	115	0

The all-atom clashscore is defined as the number of clashes found per 1000 atoms (including hydrogen atoms). The all-atom clashscore for this structure is 4.

The worst 5 of 115 close contacts within the same asymmetric unit are listed below, sorted by their clash magnitude.

Atom-1	Atom-2	Interatomic distance (Å)	Clash overlap (Å)
1:D:90:ARG:NH1	6:D:401:HOH:O	1.56	1.37
2:B:148:GLN:NE2	2:B:155:LEU:HD12	1.53	1.22
2:B:148:GLN:HE21	2:B:155:LEU:HD12	1.05	1.11
2:B:189:LYS:HE3	2:B:189:LYS:HA	1.41	1.02
2:I:150:LYS:NZ	2:I:196:GLU:OE1	2.00	0.95

There are no symmetry-related clashes.

5.3 Torsion angles [i](#)

5.3.1 Protein backbone [i](#)

In the following table, the Percentiles column shows the percent Ramachandran outliers of the chain as a percentile score with respect to all X-ray entries followed by that with respect to entries of similar resolution.

The Analysed column shows the number of residues for which the backbone conformation was analysed, and the total number of residues.

Mol	Chain	Analysed	Favoured	Allowed	Outliers	Percentiles	
1	A	223/229 (97%)	218 (98%)	5 (2%)	0	100	100
1	D	224/229 (98%)	219 (98%)	5 (2%)	0	100	100
1	G	216/229 (94%)	212 (98%)	4 (2%)	0	100	100
1	H	219/229 (96%)	213 (97%)	6 (3%)	0	100	100
2	B	213/214 (100%)	209 (98%)	4 (2%)	0	100	100
2	E	213/214 (100%)	210 (99%)	3 (1%)	0	100	100
2	I	212/214 (99%)	206 (97%)	6 (3%)	0	100	100
2	L	214/214 (100%)	210 (98%)	4 (2%)	0	100	100
All	All	1734/1772 (98%)	1697 (98%)	37 (2%)	0	100	100

There are no Ramachandran outliers to report.

5.3.2 Protein sidechains [i](#)

In the following table, the Percentiles column shows the percent sidechain outliers of the chain as a percentile score with respect to all X-ray entries followed by that with respect to entries of similar

resolution.

The Analysed column shows the number of residues for which the sidechain conformation was analysed, and the total number of residues.

Mol	Chain	Analysed	Rotameric	Outliers	Percentiles	
1	A	185/190 (97%)	185 (100%)	0	100	100
1	D	186/190 (98%)	186 (100%)	0	100	100
1	G	180/190 (95%)	180 (100%)	0	100	100
1	H	184/190 (97%)	184 (100%)	0	100	100
2	B	189/189 (100%)	189 (100%)	0	100	100
2	E	189/189 (100%)	189 (100%)	0	100	100
2	I	189/189 (100%)	189 (100%)	0	100	100
2	L	191/189 (101%)	191 (100%)	0	100	100
All	All	1493/1516 (98%)	1493 (100%)	0	100	100

There are no protein residues with a non-rotameric sidechain to report.

Sometimes sidechains can be flipped to improve hydrogen bonding and reduce clashes. 5 of 20 such sidechains are listed below:

Mol	Chain	Res	Type
2	I	39	GLN
2	L	39	GLN
2	L	200	GLN
2	L	161	GLN
1	D	87	ASN

5.3.3 RNA [i](#)

Mol	Chain	Analysed	Backbone Outliers	Pucker Outliers
3	C	33/34 (97%)	9 (27%)	0
3	F	33/34 (97%)	11 (33%)	1 (3%)
3	J	33/34 (97%)	9 (27%)	0
3	R	33/34 (97%)	9 (27%)	1 (3%)
All	All	132/136 (97%)	38 (28%)	2 (1%)

5 of 38 RNA backbone outliers are listed below:

Mol	Chain	Res	Type
3	C	6	U

Continued on next page...

Continued from previous page...

Mol	Chain	Res	Type
3	C	8	C
3	C	10	A
3	C	11	G
3	C	24	U

All (2) RNA pucker outliers are listed below:

Mol	Chain	Res	Type
3	F	25	U
3	R	24	U

5.4 Non-standard residues in protein, DNA, RNA chains [i](#)

There are no non-standard protein/DNA/RNA residues in this entry.

5.5 Carbohydrates [i](#)

There are no oligosaccharides in this entry.

5.6 Ligand geometry [i](#)

Of 6 ligands modelled in this entry, 6 are monoatomic - leaving 0 for Mogul analysis.

There are no bond length outliers.

There are no bond angle outliers.

There are no chirality outliers.

There are no torsion outliers.

There are no ring outliers.

No monomer is involved in short contacts.

5.7 Other polymers [i](#)

There are no such residues in this entry.

5.8 Polymer linkage issues [i](#)

There are no chain breaks in this entry.

6 Fit of model and data [i](#)

6.1 Protein, DNA and RNA chains [i](#)

In the following table, the column labelled ‘#RSRZ > 2’ contains the number (and percentage) of RSRZ outliers, followed by percent RSRZ outliers for the chain as percentile scores relative to all X-ray entries and entries of similar resolution. The OWAB column contains the minimum, median, 95th percentile and maximum values of the occupancy-weighted average B-factor per residue. The column labelled ‘Q < 0.9’ lists the number of (and percentage) of residues with an average occupancy less than 0.9.

Mol	Chain	Analysed	<RSRZ>	#RSRZ>2	OWAB(Å ²)	Q<0.9
1	A	223/229 (97%)	-0.49	0 100 100	10, 17, 34, 57	2 (0%)
1	D	224/229 (97%)	-0.39	3 (1%) 75 80	10, 18, 37, 82	2 (0%)
1	G	218/229 (95%)	-0.34	2 (0%) 81 85	11, 20, 36, 77	2 (0%)
1	H	220/229 (96%)	-0.31	7 (3%) 50 57	11, 19, 40, 88	3 (1%)
2	B	213/214 (99%)	-0.17	3 (1%) 73 79	10, 23, 43, 73	4 (1%)
2	E	213/214 (99%)	-0.13	2 (0%) 81 85	11, 24, 42, 66	4 (1%)
2	I	213/214 (99%)	-0.03	3 (1%) 73 79	12, 27, 52, 82	3 (1%)
2	L	214/214 (100%)	-0.18	2 (0%) 81 85	10, 24, 46, 77	4 (1%)
3	C	34/34 (100%)	0.96	4 (11%) 9 10	19, 83, 123, 136	0
3	F	31/34 (91%)	1.21	8 (25%) 1 2	20, 119, 148, 161	0
3	J	31/34 (91%)	1.50	14 (45%) 0 0	21, 134, 188, 190	0
3	R	34/34 (100%)	1.63	16 (47%) 0 0	25, 115, 149, 157	0
All	All	1868/1908 (97%)	-0.15	64 (3%) 48 55	10, 22, 77, 190	24 (1%)

The worst 5 of 64 RSRZ outliers are listed below:

Mol	Chain	Res	Type	RSRZ
2	L	215	CYS	4.1
1	H	140	SER	3.7
3	F	21	C	3.6
1	G	146	GLY	3.5
1	H	142	SER	3.5

6.2 Non-standard residues in protein, DNA, RNA chains [i](#)

There are no non-standard protein/DNA/RNA residues in this entry.

6.3 Carbohydrates [i](#)

There are no oligosaccharides in this entry.

6.4 Ligands [i](#)

In the following table, the Atoms column lists the number of modelled atoms in the group and the number defined in the chemical component dictionary. The B-factors column lists the minimum, median, 95th percentile and maximum values of B factors of atoms in the group. The column labelled 'Q< 0.9' lists the number of atoms with occupancy less than 0.9.

Mol	Type	Chain	Res	Atoms	RSCC	RSR	B-factors(Å ²)	Q<0.9
4	K	H	301	1/1	0.92	0.09	22,22,22,22	1
5	NA	G	301	1/1	0.94	0.10	31,31,31,31	1
4	K	A	302	1/1	0.97	0.04	14,14,14,14	1
4	K	D	301	1/1	0.97	0.07	21,21,21,21	1
4	K	A	301	1/1	0.98	0.03	20,20,20,20	1
4	K	E	301	1/1	0.99	0.23	37,37,37,37	0

6.5 Other polymers [i](#)

There are no such residues in this entry.