



Full wwPDB X-ray Structure Validation Report ⓘ

Feb 1, 2016 – 07:03 PM GMT

PDB ID : 4NLK
Title : Structure of human DNA polymerase beta complexed with 8BrG in the template base-paired with incoming non-hydrolyzable CTP
Authors : Koag, M.-C.; Min, K.; Monzingo, A.F.; Lee, S.
Deposited on : 2013-11-14
Resolution : 2.49 Å(reported)

This is a Full wwPDB X-ray Structure Validation Report for a publicly released PDB entry.
We welcome your comments at validation@mail.wwpdb.org
A user guide is available at
<http://wwpdb.org/validation/2016/XrayValidationReportHelp>
with specific help available everywhere you see the ⓘ symbol.

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

MolProbity : 4.02b-467
Mogul : 1.7 (RC4), CSD as536be (2015)
Xtriage (Phenix) : 1.9-1692
EDS : rb-20026688
Percentile statistics : 20151230.v01 (using entries in the PDB archive December 30th 2015)
Refmac : 5.8.0135
CCP4 : 6.5.0
Ideal geometry (proteins) : Engh & Huber (2001)
Ideal geometry (DNA, RNA) : Parkinson et al. (1996)
Validation Pipeline (wwPDB-VP) : trunk26865

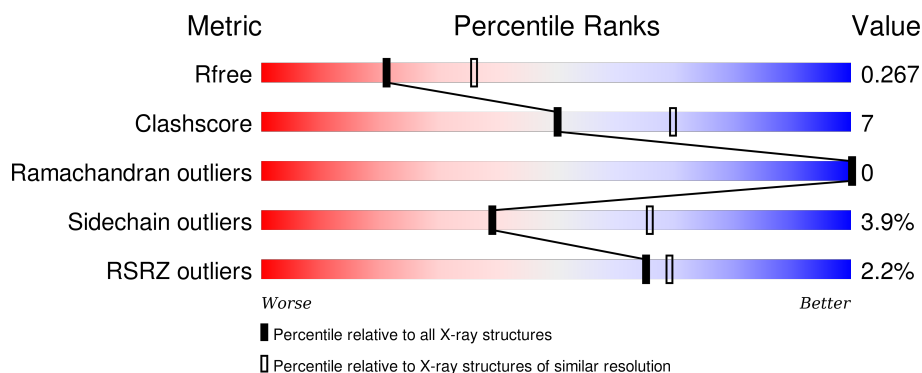
1 Overall quality at a glance

The following experimental techniques were used to determine the structure:

X-RAY DIFFRACTION

The reported resolution of this entry is 2.49 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}	91344	3553 (2.50-2.50)
Clashscore	102246	4242 (2.50-2.50)
Ramachandran outliers	100387	4156 (2.50-2.50)
Sidechain outliers	100360	4158 (2.50-2.50)
RSRZ outliers	91569	3562 (2.50-2.50)

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 on the lower bar indicate the fraction of residues that contain outliers for ≥ 3 , 2, 1 and 0 types of geometric quality criteria. 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	T	16	
2	P	10	
3	D	5	
4	A	329	

2 Entry composition

There are 8 unique types of molecules in this entry. The entry contains 3339 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 DNA chain called 5'-D(*CP*CP*GP*AP*CP*(BGM)P*TP*CP*GP*CP*AP*TP*CP*AP*GP*C)-3'.

Mol	Chain	Residues	Atoms						ZeroOcc	AltConf	Trace
1	T	16	Total	Br	C	N	O	P	0	0	0
			322	1	153	60	93	15			

- Molecule 2 is a DNA chain called 5'-D(*GP*CP*TP*GP*AP*TP*GP*CP*GP*A)-3'.

Mol	Chain	Residues	Atoms					ZeroOcc	AltConf	Trace
2	P	10	Total	C	N	O	P	0	0	0
			205	98	40	58	9			

- Molecule 3 is a DNA chain called 5'-D(P*GP*TP*CP*GP*G)-3'.

Mol	Chain	Residues	Atoms					ZeroOcc	AltConf	Trace
3	D	5	Total	C	N	O	P	0	0	0
			106	49	20	32	5			

- Molecule 4 is a protein called DNA polymerase beta.

Mol	Chain	Residues	Atoms					ZeroOcc	AltConf	Trace
4	A	326	Total	C	N	O	S	0	0	0
			2608	1647	456	496	9			

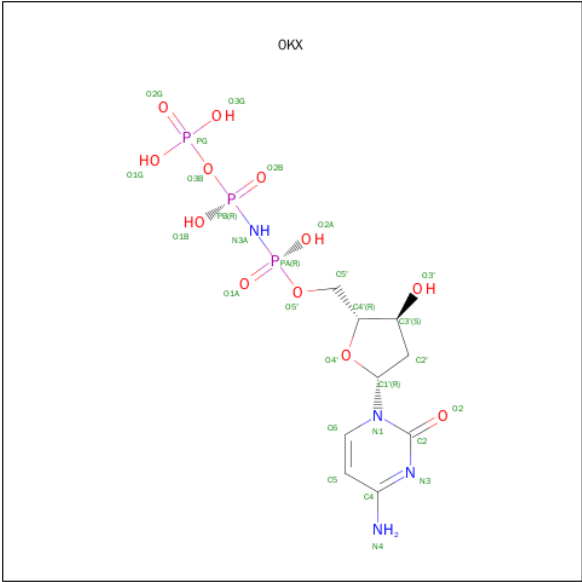
- Molecule 5 is MAGNESIUM ION (three-letter code: MG) (formula: Mg).

Mol	Chain	Residues	Atoms		ZeroOcc	AltConf
5	A	2	Total	Mg	0	0
			2	2		

- Molecule 6 is SODIUM ION (three-letter code: NA) (formula: Na).

Mol	Chain	Residues	Atoms		ZeroOcc	AltConf
6	A	2	Total	Na	0	0
			2	2		

- Molecule 7 is 2'-DEOXY-5'-O-[(R)-HYDROXY{[(R)-HYDROXY(PHOSPHONOOXY)PHOSPHORYL]AMINO}PHOSPHORYL]CYTIDINE (three-letter code: 0KX) (formula: C₉H₁₇N₄O₁₂P₃).

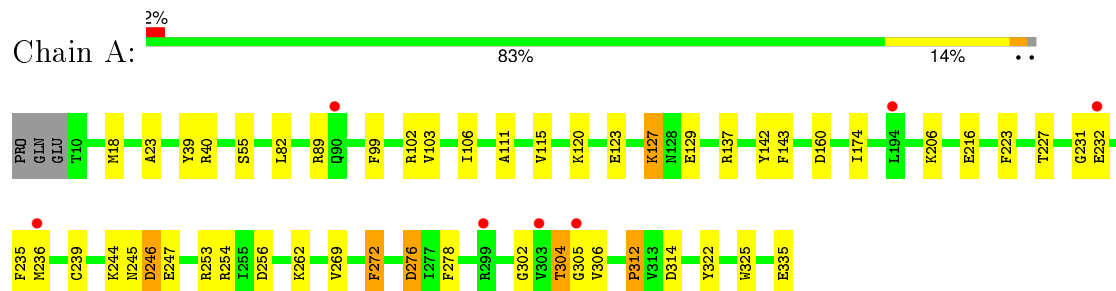


Mol	Chain	Residues	Atoms					ZeroOcc	AltConf
7	A	1	Total	C	N	O	P	0	0
			28	9	4	12	3		

- Molecule 8 is water.

Mol	Chain	Residues	Atoms		ZeroOcc	AltConf
8	T	3	Total	O	0	0
			3	3		
8	P	6	Total	O	0	0
			6	6		
8	A	57	Total	O	0	0
			57	57		

• Molecule 1: 5'-D(*CP*CP*GP*AP*CP*(BGM)P*TP*CP*GP*CP*AP*TP*CP*AP*GP*C)-3'



4 Data and refinement statistics

Property	Value	Source
Space group	P 1 21 1	Depositor
Cell constants a, b, c, α , β , γ	50.81Å 79.71Å 55.68Å 90.00° 107.83° 90.00°	Depositor
Resolution (Å)	53.01 – 2.49 20.06 – 2.49	Depositor EDS
% Data completeness (in resolution range)	95.9 (53.01-2.49) 96.1 (20.06-2.49)	Depositor EDS
R_{merge}	(Not available)	Depositor
R_{sym}	(Not available)	Depositor
$\langle I/\sigma(I) \rangle$ ¹	3.17 (at 2.50Å)	Xtriage
Refinement program	REFMAC 5.6.0117	Depositor
R, R_{free}	0.194 , 0.270 0.193 , 0.267	Depositor DCC
R_{free} test set	737 reflections (5.45%)	DCC
Wilson B-factor (Å ²)	33.8	Xtriage
Anisotropy	0.160	Xtriage
Bulk solvent k_{sol} (e/Å ³), B_{sol} (Å ²)	0.34 , 28.8	EDS
Estimated twinning fraction	No twinning to report.	Xtriage
L-test for twinning ²	$\langle L \rangle = 0.47$, $\langle L^2 \rangle = 0.30$	Xtriage
Outliers	0 of 14564 reflections	Xtriage
F_o, F_c correlation	0.94	EDS
Total number of atoms	3339	wwPDB-VP
Average B, all atoms (Å ²)	33.0	wwPDB-VP

Xtriage's analysis on translational NCS is as follows: *The largest off-origin peak in the Patterson function is 6.47% of the height of the origin peak. No significant pseudotranslation is detected.*

¹Intensities estimated from amplitudes.

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

5 Model quality ⓘ

5.1 Standard geometry ⓘ

Bond lengths and bond angles in the following residue types are not validated in this section: NA, MG, 0KX, BGM

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	T	0.43	0/334	1.13	3/512 (0.6%)
2	P	0.39	0/230	1.11	3/354 (0.8%)
3	D	1.04	1/118 (0.8%)	0.88	1/179 (0.6%)
4	A	0.68	0/2657	0.77	2/3571 (0.1%)
All	All	0.66	1/3339 (0.0%)	0.85	9/4616 (0.2%)

All (1) bond length outliers are listed below:

Mol	Chain	Res	Type	Atoms	Z	Observed(Å)	Ideal(Å)
3	D	1	DG	OP3-P	-10.35	1.48	1.61

All (9) bond angle outliers are listed below:

Mol	Chain	Res	Type	Atoms	Z	Observed(°)	Ideal(°)
2	P	4	DG	P-O3'-C3'	9.55	131.16	119.70
1	T	10	DC	P-O3'-C3'	9.28	130.84	119.70
1	T	12	DT	P-O3'-C3'	7.93	129.22	119.70
2	P	8	DC	P-O3'-C3'	7.03	128.13	119.70
2	P	7	DG	O3'-P-O5'	-5.88	92.82	104.00
3	D	3	DC	P-O3'-C3'	5.74	126.58	119.70
1	T	14	DA	P-O3'-C3'	5.23	125.98	119.70
4	A	276	ASP	CB-CG-OD1	5.10	122.89	118.30
4	A	253	ARG	NE-CZ-NH2	-5.10	117.75	120.30

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	T	322	0	179	7	0
2	P	205	0	114	3	0
3	D	106	0	57	1	0
4	A	2608	0	2616	34	0
5	A	2	0	0	0	0
6	A	2	0	0	0	0
7	A	28	0	15	0	0
8	A	57	0	0	9	0
8	P	6	0	0	1	0
8	T	3	0	0	0	0
All	All	3339	0	2981	44	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 7.

All (44) 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)
4:A:160:ASP:HB3	8:A:518:HOH:O	1.15	1.25
1:T:5:DC:H2''	1:T:6:BGM:OP2	1.62	1.00
1:T:4:DA:H2''	1:T:5:DC:OP2	1.84	0.78
4:A:232:GLU:HG2	8:A:512:HOH:O	1.85	0.76
4:A:160:ASP:CB	8:A:518:HOH:O	1.91	0.71
1:T:6:BGM:BR	1:T:6:BGM:H2'	2.47	0.68
2:P:1:DG:H2'	2:P:2:DC:C6	2.34	0.63
4:A:278:PHE:HB2	4:A:335:GLU:HG3	1.80	0.61
1:T:3:DG:H2''	1:T:4:DA:C8	2.36	0.59
4:A:232:GLU:CG	8:A:512:HOH:O	2.49	0.57
4:A:160:ASP:CG	8:A:518:HOH:O	2.30	0.57
4:A:123:GLU:O	4:A:127:LYS:HG2	2.05	0.57
4:A:18:MET:SD	4:A:82:LEU:HD22	2.44	0.57
4:A:99:PHE:O	4:A:102:ARG:HB2	2.04	0.57
3:D:4:DG:H2''	3:D:5:DG:OP2	2.05	0.56
4:A:216:GLU:CG	8:A:530:HOH:O	2.54	0.55
4:A:236:MET:HG2	4:A:256:ASP:OD1	2.06	0.55

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Atom-1	Atom-2	Interatomic distance (Å)	Clash overlap (Å)
4:A:245:ASN:O	4:A:246:ASP:HB2	2.07	0.54
4:A:244:LYS:HG3	4:A:247:GLU:OE2	2.08	0.53
4:A:312:PRO:HD2	4:A:322:TYR:OH	2.08	0.53
4:A:216:GLU:HG2	8:A:530:HOH:O	2.08	0.53
4:A:174:ILE:HD12	4:A:262:LYS:NZ	2.25	0.52
4:A:302:GLY:O	4:A:305:GLY:N	2.35	0.52
4:A:206:LYS:HE2	8:A:545:HOH:O	2.10	0.52
4:A:142:TYR:O	4:A:143:PHE:C	2.46	0.50
4:A:227:THR:HG23	4:A:235:PHE:CE1	2.48	0.49
4:A:103:VAL:HB	4:A:106:ILE:HD12	1.95	0.48
1:T:10:DC:OP1	4:A:231:GLY:HA3	2.14	0.48
1:T:1:DC:H2"	1:T:2:DC:C6	2.48	0.47
4:A:304:THR:O	4:A:304:THR:OG1	2.30	0.47
4:A:40:ARG:NH2	4:A:276:ASP:OD2	2.34	0.47
2:P:1:DG:H2"	2:P:2:DC:H5'	1.96	0.46
4:A:23:ALA:HB2	4:A:39:TYR:HB3	1.98	0.46
4:A:216:GLU:HG3	8:A:530:HOH:O	2.16	0.45
2:P:8:DC:H2"	2:P:9:DG:O5'	2.16	0.44
1:T:2:DC:H2"	1:T:3:DG:C8	2.52	0.43
4:A:254:ARG:CZ	4:A:254:ARG:HB3	2.48	0.43
4:A:129:GLU:O	4:A:137:ARG:NH2	2.51	0.43
4:A:137:ARG:HB2	4:A:137:ARG:HE	1.63	0.41
4:A:223:PHE:O	4:A:239:CYS:HA	2.19	0.41
4:A:272:PHE:HD1	4:A:272:PHE:HA	1.75	0.41
8:P:106:HOH:O	4:A:256:ASP:HB3	2.20	0.40
4:A:89:ARG:HD2	4:A:89:ARG:HH11	1.76	0.40
4:A:111:ALA:O	4:A:115:VAL:HG23	2.21	0.40

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	
4	A	324/329 (98%)	315 (97%)	9 (3%)	0	100	100

There are no Ramachandran outliers to report.

5.3.2 Protein sidechains ⓘ

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	
4	A	285/290 (98%)	274 (96%)	11 (4%)	39	66

All (11) residues with a non-rotameric sidechain are listed below:

Mol	Chain	Res	Type
4	A	55	SER
4	A	120	LYS
4	A	127	LYS
4	A	246	ASP
4	A	269	VAL
4	A	272	PHE
4	A	304	THR
4	A	306	VAL
4	A	312	PRO
4	A	314	ASP
4	A	325	TRP

Some sidechains can be flipped to improve hydrogen bonding and reduce clashes. All (2) such sidechains are listed below:

Mol	Chain	Res	Type
4	A	207	GLN
4	A	264	GLN

5.3.3 RNA ⓘ

There are no RNA molecules in this entry.

5.4 Non-standard residues in protein, DNA, RNA chains ⓘ

1 non-standard protein/DNA/RNA residue is modelled in this entry.

In the following table, the Counts columns list the number of bonds (or angles) for which Mogul statistics could be retrieved, the number of bonds (or angles) that are observed in the model and the number of bonds (or angles) that are defined in the chemical component dictionary. The Link column lists molecule types, if any, to which the group is linked. 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 $|Z| > 2$ is considered an outlier worth inspection. RMSZ is the root-mean-square of all Z scores of the bond lengths (or angles).

Mol	Type	Chain	Res	Link	Bond lengths			Bond angles		
					Counts	RMSZ	$\# Z > 2$	Counts	RMSZ	$\# Z > 2$
1	BGM	T	6	1	17,25,26	1.12	2 (11%)	20,37,40	2.76	7 (35%)

In the following table, the Chirals column lists the number of chiral outliers, the number of chiral centers analysed, the number of these observed in the model and the number defined in the chemical component dictionary. Similar counts are reported in the Torsion and Rings columns. '-' means no outliers of that kind were identified.

Mol	Type	Chain	Res	Link	Chirals	Torsions	Rings
1	BGM	T	6	1	-	0/3/21/22	0/3/3/3

All (2) bond length outliers are listed below:

Mol	Chain	Res	Type	Atoms	Z	Observed(Å)	Ideal(Å)
1	T	6	BGM	C5-C4	2.45	1.46	1.40
1	T	6	BGM	C6-C5	3.10	1.47	1.41

All (7) bond angle outliers are listed below:

Mol	Chain	Res	Type	Atoms	Z	Observed(°)	Ideal(°)
1	T	6	BGM	O4'-C1'-N9	-6.52	102.70	108.22
1	T	6	BGM	C6-C5-C4	-4.05	116.05	120.90
1	T	6	BGM	N3-C2-N1	-3.84	121.60	127.44
1	T	6	BGM	C5-C6-N1	-3.40	118.94	123.59
1	T	6	BGM	O3'-C3'-C4'	-2.29	100.78	110.05
1	T	6	BGM	C6-N1-C2	4.43	122.09	115.94
1	T	6	BGM	C2'-C1'-N9	5.26	121.09	115.83

There are no chirality outliers.

There are no torsion outliers.

There are no ring outliers.

1 monomer is involved in 2 short contacts:

Mol	Chain	Res	Type	Clashes	Symm-Clashes
1	T	6	BGM	2	0

5.5 Carbohydrates [i](#)

There are no carbohydrates in this entry.

5.6 Ligand geometry [i](#)

Of 5 ligands modelled in this entry, 4 are monoatomic - leaving 1 for Mogul analysis.

In the following table, the Counts columns list the number of bonds (or angles) for which Mogul statistics could be retrieved, the number of bonds (or angles) that are observed in the model and the number of bonds (or angles) that are defined in the chemical component dictionary. The Link column lists molecule types, if any, to which the group is linked. 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 $|Z| > 2$ is considered an outlier worth inspection. RMSZ is the root-mean-square of all Z scores of the bond lengths (or angles).

Mol	Type	Chain	Res	Link	Bond lengths			Bond angles		
					Counts	RMSZ	$\# Z > 2$	Counts	RMSZ	$\# Z > 2$
7	0KX	A	405	5	24,29,29	4.70	8 (33%)	33,45,45	2.36	8 (24%)

In the following table, the Chirals column lists the number of chiral outliers, the number of chiral centers analysed, the number of these observed in the model and the number defined in the chemical component dictionary. Similar counts are reported in the Torsion and Rings columns. '-' means no outliers of that kind were identified.

Mol	Type	Chain	Res	Link	Chirals	Torsions	Rings
7	0KX	A	405	5	-	0/13/34/34	0/2/2/2

All (8) bond length outliers are listed below:

Mol	Chain	Res	Type	Atoms	Z	Observed(Å)	Ideal(Å)
7	A	405	0KX	PB-O1B	-2.34	1.50	1.56
7	A	405	0KX	PA-O2A	-2.02	1.51	1.56
7	A	405	0KX	PA-O5'	2.79	1.65	1.57
7	A	405	0KX	C4-N3	3.07	1.41	1.35
7	A	405	0KX	PB-O3B	3.40	1.63	1.59
7	A	405	0KX	C6-N1	5.44	1.43	1.35
7	A	405	0KX	PB-O2B	13.77	1.62	1.46
7	A	405	0KX	PA-O1A	16.20	1.64	1.46

All (8) bond angle outliers are listed below:

Mol	Chain	Res	Type	Atoms	Z	Observed($^{\circ}$)	Ideal($^{\circ}$)
7	A	405	0KX	O2B-PB-N3A	-8.08	99.51	111.90
7	A	405	0KX	O1A-PA-N3A	-6.71	101.61	111.90
7	A	405	0KX	PG-O3B-PB	-4.16	118.72	132.67
7	A	405	0KX	C2'-C1'-N1	-2.68	107.64	114.16
7	A	405	0KX	O5'-PA-O1A	-2.24	104.04	113.31
7	A	405	0KX	O3G-PG-O3B	2.24	115.25	105.09
7	A	405	0KX	C2-N3-C4	2.71	119.44	115.61
7	A	405	0KX	O2A-PA-O1A	3.18	116.63	110.00

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	T	15/16 (93%)	0.15	1 (6%) 21 23	25, 39, 84, 87	0
2	P	10/10 (100%)	-0.57	0 100 100	28, 42, 45, 48	0
3	D	5/5 (100%)	-0.05	0 100 100	31, 38, 53, 62	0
4	A	326/329 (99%)	-0.22	7 (2%) 67 71	15, 30, 49, 77	7 (2%)
All	All	356/360 (98%)	-0.21	8 (2%) 65 69	15, 30, 52, 87	7 (1%)

All (8) RSRZ outliers are listed below:

Mol	Chain	Res	Type	RSRZ
4	A	194	LEU	5.9
4	A	236	MET	5.3
4	A	232	GLU	3.8
4	A	303	VAL	3.3
4	A	305	GLY	2.2
4	A	299	ARG	2.2
4	A	90	GLN	2.1
1	T	3	DG	2.0

6.2 Non-standard residues in protein, DNA, RNA chains [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. LLDF column lists the quality of electron density of the group with respect to its neighbouring residues in protein, DNA or RNA chains. 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	LLDF	B-factors(Å ²)	Q<0.9
1	BGM	T	6	23/24	0.97	0.11	-	28,34,65,83	0

6.3 Carbohydrates [i](#)

There are no carbohydrates 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. LLDF column lists the quality of electron density of the group with respect to its neighbouring residues in protein, DNA or RNA chains. 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	LLDF	B-factors(\AA^2)	Q<0.9
6	NA	A	403	1/1	0.94	0.12	-0.72	22,22,22,22	0
7	OKX	A	405	28/28	0.98	0.09	-1.29	19,20,23,23	0
6	NA	A	404	1/1	0.91	0.09	-2.68	36,36,36,36	0
5	MG	A	402	1/1	0.97	0.05	-	31,31,31,31	0
5	MG	A	401	1/1	0.92	0.10	-	17,17,17,17	0

6.5 Other polymers [i](#)

There are no such residues in this entry.