



wwPDB X-ray Structure Validation Summary Report ⓘ

Mar 8, 2026 – 11:01 AM UTC

PDB ID : 5W6Q / pdb_00005w6q
Title : Structural basis for recognition of artificial DNA by an evolved KlenTaq variant
Authors : Singh, I.; Georgiadis, M.M.
Deposited on : 2017-06-16
Resolution : 2.66 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
Mogul : 2022.3.0, CSD as543be (2022)
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

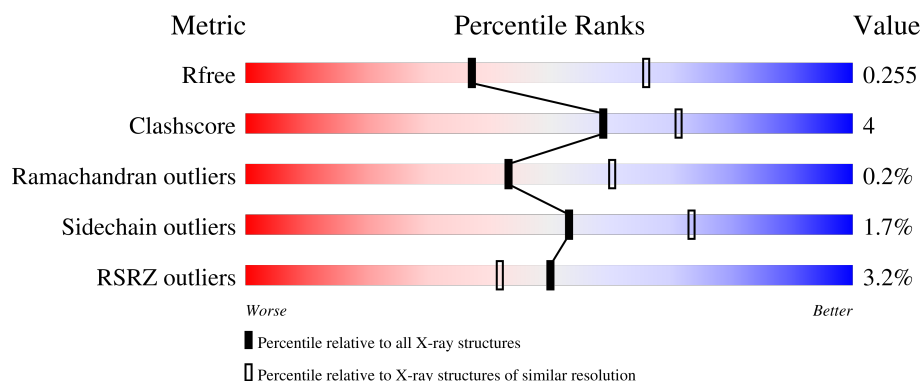
1 Overall quality at a glance

The following experimental techniques were used to determine the structure:

X-RAY DIFFRACTION

The reported resolution of this entry is 2.66 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	1110 (2.66-2.66)
Clashscore	190562	1141 (2.66-2.66)
Ramachandran outliers	187476	1126 (2.66-2.66)
Sidechain outliers	187428	1126 (2.66-2.66)
RSRZ outliers	180081	1110 (2.66-2.66)

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	540	5% 85% 9% • 5%
1	C	540	2% 82% 13% • •
1	G	540	3% 84% 12% • •
2	B	12	58% 33% 8%
2	E	12	50% 50%

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Mol	Chain	Length	Quality of chain
2	H	12	 50% 50%
3	D	13	 69% 31%
3	F	13	 62% 38%
3	I	13	 8% 69% 31%

2 Entry composition

There are 4 unique types of molecules in this entry. The entry contains 14188 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 DNA polymerase I, thermostable.

Mol	Chain	Residues	Atoms					ZeroOcc	AltConf	Trace
1	A	515	Total	C	N	O	S	0	1	0
			4069	2587	730	742	10			
1	C	521	Total	C	N	O	S	0	1	0
			4117	2617	743	747	10			
1	G	527	Total	C	N	O	S	0	2	0
			4165	2652	746	756	11			

There are 12 discrepancies between the modelled and reference sequences:

Chain	Residue	Modelled	Actual	Comment	Reference
A	444	VAL	MET	engineered mutation	UNP P19821
A	527	ALA	PRO	engineered mutation	UNP P19821
A	551	GLU	ASP	engineered mutation	UNP P19821
A	832	VAL	GLU	engineered mutation	UNP P19821
C	444	VAL	MET	engineered mutation	UNP P19821
C	527	ALA	PRO	engineered mutation	UNP P19821
C	551	GLU	ASP	engineered mutation	UNP P19821
C	832	VAL	GLU	engineered mutation	UNP P19821
G	444	VAL	MET	engineered mutation	UNP P19821
G	527	ALA	PRO	engineered mutation	UNP P19821
G	551	GLU	ASP	engineered mutation	UNP P19821
G	832	VAL	GLU	engineered mutation	UNP P19821

- Molecule 2 is a DNA chain called DNA (5'-D(*GP*AP*CP*CP*AP*CP*GP*GP*CP*GP*CP*(1W5))-3').

Mol	Chain	Residues	Atoms					ZeroOcc	AltConf	Trace
2	B	12	Total	C	N	O	P	0	0	0
			244	115	48	70	11			
2	E	12	Total	C	N	O	P	0	0	0
			244	115	48	70	11			

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Mol	Chain	Residues	Atoms					ZeroOcc	AltConf	Trace
2	H	12	Total	C	N	O	P	0	0	0
			244	115	48	70	11			

- Molecule 3 is a DNA chain called DNA (5'-D(P*GP*(1WA)P*GP*CP*GP*CP*CP*GP*TP*GP*GP*TP*C)-3').

Mol	Chain	Residues	Atoms					ZeroOcc	AltConf	Trace
3	D	13	Total	C	N	O	P	0	0	0
			270	126	51	80	13			
3	F	13	Total	C	N	O	P	0	0	0
			270	126	51	80	13			
3	I	13	Total	C	N	O	P	0	0	0
			270	126	51	80	13			

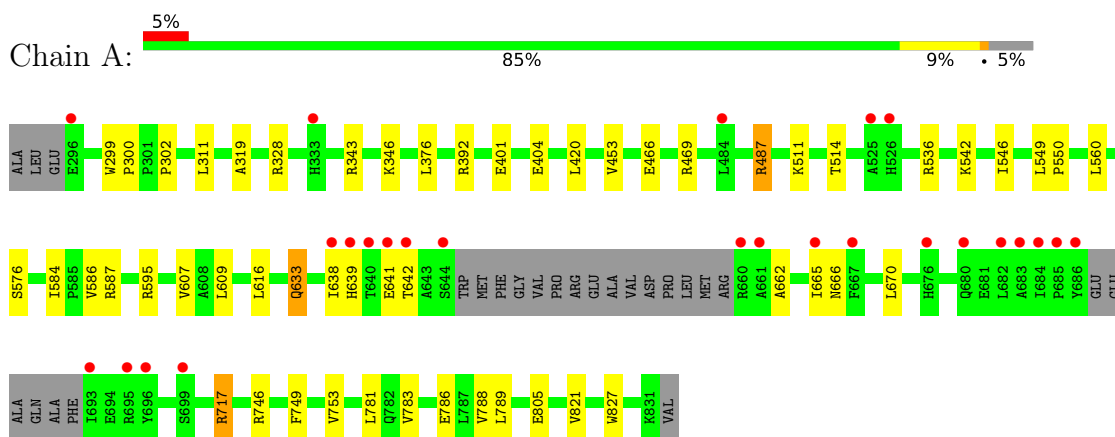
- Molecule 4 is water.

Mol	Chain	Residues	Atoms		ZeroOcc	AltConf
4	A	83	Total	O	0	0
			83	83		
4	B	5	Total	O	0	0
			5	5		
4	D	15	Total	O	0	0
			15	15		
4	C	64	Total	O	0	0
			64	64		
4	E	8	Total	O	0	0
			8	8		
4	F	14	Total	O	0	0
			14	14		
4	G	85	Total	O	0	0
			85	85		
4	H	11	Total	O	0	0
			11	11		
4	I	10	Total	O	0	0
			10	10		

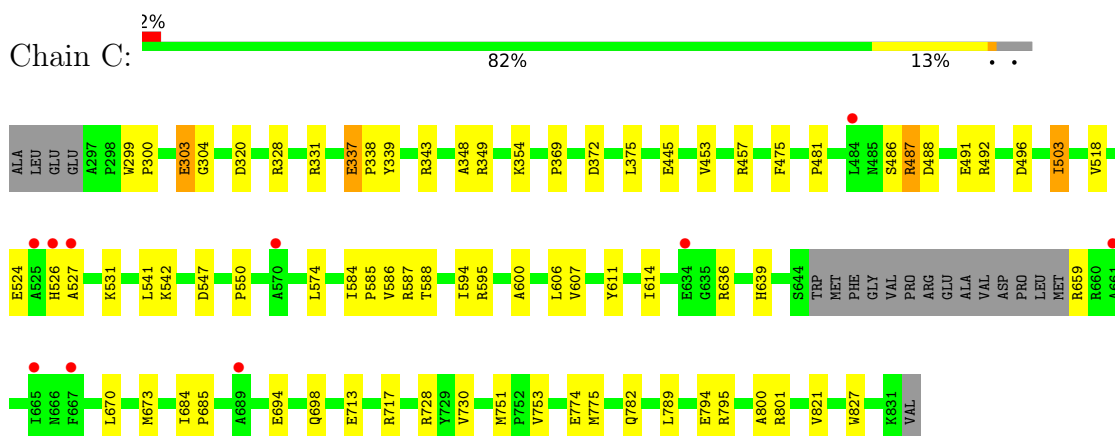
3 Residue-property plots [i](#)

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.

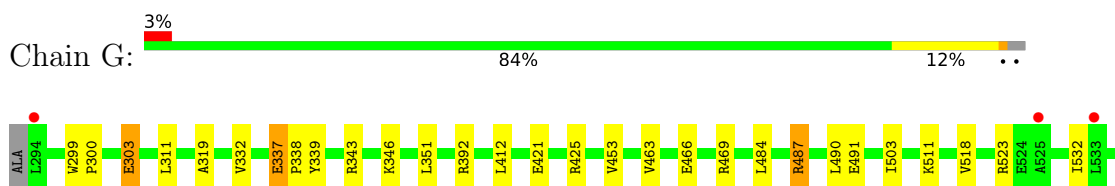
- Molecule 1: DNA polymerase I, thermostable

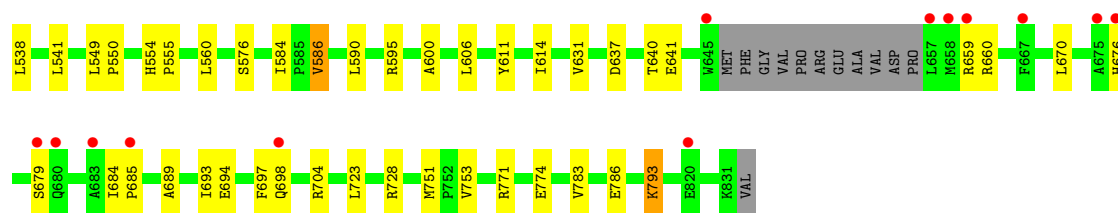


- Molecule 1: DNA polymerase I, thermostable



- Molecule 1: DNA polymerase I, thermostable

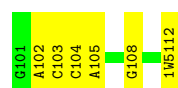




- Molecule 2: DNA (5'-D(*GP*AP*CP*CP*AP*CP*GP*GP*CP*GP*CP*(1W5))-3')



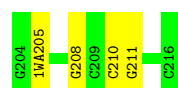
- Molecule 2: DNA (5'-D(*GP*AP*CP*CP*AP*CP*GP*GP*CP*GP*CP*(1W5))-3')



- Molecule 2: DNA (5'-D(*GP*AP*CP*CP*AP*CP*GP*GP*CP*GP*CP*(1W5))-3')



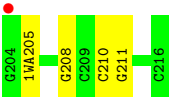
- Molecule 3: DNA (5'-D(P*GP*(1WA)P*GP*CP*GP*CP*CP*GP*TP*GP*GP*TP*C)-3')



- Molecule 3: DNA (5'-D(P*GP*(1WA)P*GP*CP*GP*CP*CP*GP*TP*GP*GP*TP*C)-3')



- Molecule 3: DNA (5'-D(P*GP*(1WA)P*GP*CP*GP*CP*CP*GP*TP*GP*GP*TP*C)-3')



4 Data and refinement statistics

Property	Value	Source
Space group	C 1 2 1	Depositor
Cell constants a, b, c, α , β , γ	199.28Å 114.61Å 90.52Å 90.00° 91.88° 90.00°	Depositor
Resolution (Å)	49.13 – 2.66 49.13 – 2.66	Depositor EDS
% Data completeness (in resolution range)	98.5 (49.13-2.66) 98.5 (49.13-2.66)	Depositor EDS
R_{merge}	(Not available)	Depositor
R_{sym}	0.08	Depositor
$\langle I/\sigma(I) \rangle$ ¹	2.19 (at 2.65Å)	Xtriage
Refinement program	PHENIX 1.9_1692	Depositor
R, R_{free}	0.211 , 0.247 0.221 , 0.255	Depositor DCC
R_{free} test set	2819 reflections (4.82%)	wwPDB-VP
Wilson B-factor (Å ²)	39.8	Xtriage
Anisotropy	0.148	Xtriage
Bulk solvent k_{sol} (e/Å ³), B_{sol} (Å ²)	0.34 , 30.9	EDS
L-test for twinning ²	$\langle L \rangle = 0.49$, $\langle L^2 \rangle = 0.32$	Xtriage
Estimated twinning fraction	0.017 for -1/2*h-3/2*k,-1/2*h+1/2*k,-l 0.016 for -1/2*h+3/2*k,1/2*h+1/2*k,-l 0.056 for 1/2*h-3/2*k,-1/2*h-1/2*k,-l 0.085 for 1/2*h+3/2*k,1/2*h-1/2*k,-l 0.024 for -h,-k,l	Xtriage
F_o, F_c correlation	0.92	EDS
Total number of atoms	14188	wwPDB-VP
Average B, all atoms (Å ²)	39.0	wwPDB-VP

Xtriage's analysis on translational NCS is as follows: *The largest off-origin peak in the Patterson function is 2.91% 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, 0.333 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: 1W5, 1WA

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	0.31	0/4153	0.70	0/5625
1	C	0.30	0/4203	0.70	4/5693 (0.1%)
1	G	0.29	0/4256	0.73	4/5767 (0.1%)
2	B	0.17	0/249	0.27	0/382
2	E	0.19	0/249	0.32	0/382
2	H	0.19	0/249	0.31	0/382
3	D	0.19	0/276	0.33	0/422
3	F	0.18	0/276	0.33	0/422
3	I	0.19	0/276	0.33	0/422
All	All	0.29	0/14187	0.67	8/19497 (0.0%)

There are no bond length outliers.

The worst 5 of 8 bond angle outliers are listed below:

Mol	Chain	Res	Type	Atoms	Z	Observed(°)	Ideal(°)
1	G	697	PHE	CA-C-N	-6.01	112.62	122.54
1	G	697	PHE	C-N-CA	-6.01	112.62	122.54
1	G	337	GLU	CA-C-N	5.66	124.85	118.97
1	G	337	GLU	C-N-CA	5.66	124.85	118.97
1	C	730	VAL	CA-C-N	5.64	126.89	119.84

There are no chirality outliers.

There are no planarity outliers.

5.2 Too-close contacts [i](#)

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	4069	0	4117	30	0
1	C	4117	0	4167	43	0
1	G	4165	0	4205	39	0
2	B	244	0	133	4	0
2	E	244	0	133	3	0
2	H	244	0	133	4	0
3	D	270	0	147	2	0
3	F	270	0	147	3	0
3	I	270	0	147	2	0
4	A	83	0	0	0	0
4	B	5	0	0	0	0
4	C	64	0	0	0	0
4	D	15	0	0	0	0
4	E	8	0	0	0	0
4	F	14	0	0	0	0
4	G	85	0	0	0	0
4	H	11	0	0	0	0
4	I	10	0	0	0	0
All	All	14188	0	13329	118	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 118 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:A:639:HIS:HA	1:A:642:THR:HG22	1.60	0.83
1:G:684:ILE:HG13	1:G:685:PRO:HD2	1.61	0.81
1:C:794:GLU:HG3	1:C:795:ARG:HG2	1.66	0.78
1:A:302:PRO:HG2	1:A:328:ARG:HD3	1.68	0.76
1:A:584:ILE:O	1:A:595:ARG:NH1	2.23	0.70

There are no symmetry-related clashes.

5.3 Torsion angles

5.3.1 Protein backbone

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	510/540 (94%)	487 (96%)	22 (4%)	1 (0%)	43	60
1	C	518/540 (96%)	499 (96%)	18 (4%)	1 (0%)	43	60
1	G	525/540 (97%)	503 (96%)	21 (4%)	1 (0%)	43	60
All	All	1553/1620 (96%)	1489 (96%)	61 (4%)	3 (0%)	43	60

All (3) Ramachandran outliers are listed below:

Mol	Chain	Res	Type
1	C	586	VAL
1	G	586	VAL
1	A	586	VAL

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	
1	A	417/440 (95%)	407 (98%)	10 (2%)	43	65
1	C	420/440 (96%)	414 (99%)	6 (1%)	59	76
1	G	424/440 (96%)	416 (98%)	8 (2%)	50	71
All	All	1261/1320 (96%)	1237 (98%)	24 (2%)	53	71

5 of 24 residues with a non-rotameric sidechain are listed below:

Mol	Chain	Res	Type
1	C	636	ARG
1	G	332	VAL
1	G	303	GLU
1	G	392	ARG
1	A	633	GLN

Sometimes sidechains can be flipped to improve hydrogen bonding and reduce clashes. 5 of 7 such sidechains are listed below:

Mol	Chain	Res	Type
1	G	485	ASN
1	G	554	HIS
1	G	754	GLN
1	G	633	GLN
1	C	582	GLN

5.3.3 RNA ⓘ

There are no RNA molecules in this entry.

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

6 non-standard protein/DNA/RNA residues are 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
2	1W5	B	112	2	19,23,24	1.54	4 (21%)	18,33,36	2.28	3 (16%)
3	1WA	I	205	3	16,24,25	0.98	1 (6%)	16,35,38	2.04	3 (18%)
2	1W5	E	112	2	19,23,24	1.55	4 (21%)	18,33,36	2.27	3 (16%)
3	1WA	F	205	3	16,24,25	0.99	1 (6%)	16,35,38	2.00	3 (18%)
2	1W5	H	112	2	19,23,24	1.54	4 (21%)	18,33,36	2.24	3 (16%)
3	1WA	D	205	3	16,24,25	1.01	1 (6%)	16,35,38	2.01	3 (18%)

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
2	1W5	B	112	2	-	0/8/25/26	0/2/2/2
3	1WA	I	205	3	-	3/5/21/22	0/2/3/3
2	1W5	E	112	2	-	0/8/25/26	0/2/2/2
3	1WA	F	205	3	-	2/5/21/22	0/2/3/3
2	1W5	H	112	2	-	0/8/25/26	0/2/2/2
3	1WA	D	205	3	-	2/5/21/22	0/2/3/3

The worst 5 of 15 bond length outliers are listed below:

Mol	Chain	Res	Type	Atoms	Z	Observed(Å)	Ideal(Å)
2	E	112	1W5	C6-C1	-3.36	1.34	1.39
2	B	112	1W5	C6-C1	-3.35	1.34	1.39
2	H	112	1W5	C6-C1	-3.30	1.34	1.39
3	D	205	1WA	C4-N3	-2.84	1.30	1.35
3	F	205	1WA	C4-N3	-2.79	1.30	1.35

The worst 5 of 18 bond angle outliers are listed below:

Mol	Chain	Res	Type	Atoms	Z	Observed(°)	Ideal(°)
2	B	112	1W5	C4-N3-C2	8.58	126.89	116.98
2	E	112	1W5	C4-N3-C2	8.54	126.85	116.98
2	H	112	1W5	C4-N3-C2	8.44	126.74	116.98
3	F	205	1WA	O6-C6-N1	6.08	127.91	115.34
3	D	205	1WA	O6-C6-N1	6.07	127.88	115.34

There are no chirality outliers.

5 of 7 torsion outliers are listed below:

Mol	Chain	Res	Type	Atoms
3	I	205	1WA	O4'-C4'-C5'-O5'
3	I	205	1WA	C3'-C4'-C5'-O5'
3	F	205	1WA	O4'-C4'-C5'-O5'
3	F	205	1WA	C3'-C4'-C5'-O5'
3	D	205	1WA	O4'-C4'-C5'-O5'

There are no ring outliers.

1 monomer is involved in 1 short contact:

Mol	Chain	Res	Type	Clashes	Symm-Clashes
2	B	112	1W5	1	0

5.5 Carbohydrates [i](#)

There are no oligosaccharides in this entry.

5.6 Ligand geometry [i](#)

There are no ligands in this entry.

5.7 Other polymers [i](#)

There are no such residues in this entry.

5.8 Polymer linkage issues [i](#)

The following chains have linkage breaks:

Mol	Chain	Number of breaks
3	I	1

All chain breaks are listed below:

Model	Chain	Residue-1	Atom-1	Residue-2	Atom-2	Distance (Å)
1	I	205:1WA	O3'	206:DG	P	1.36

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	515/540 (95%)	0.27	26 (5%) 34 26	22, 38, 67, 82	1 (0%)
1	C	521/540 (96%)	0.25	10 (1%) 66 61	23, 39, 63, 71	1 (0%)
1	G	527/540 (97%)	0.10	16 (3%) 52 45	23, 35, 62, 82	2 (0%)
2	B	11/12 (91%)	-0.18	0 100 100	32, 36, 42, 43	0
2	E	11/12 (91%)	-0.30	0 100 100	31, 33, 43, 44	0
2	H	11/12 (91%)	-0.20	0 100 100	33, 38, 58, 58	0
3	D	12/13 (92%)	-0.35	0 100 100	29, 33, 43, 58	0
3	F	12/13 (92%)	-0.45	0 100 100	31, 33, 43, 52	0
3	I	12/13 (92%)	-0.23	1 (8%) 17 12	31, 36, 48, 68	0
All	All	1632/1695 (96%)	0.19	53 (3%) 50 42	22, 37, 64, 82	4 (0%)

The worst 5 of 53 RSRZ outliers are listed below:

Mol	Chain	Res	Type	RSRZ
1	A	686	TYR	4.6
1	A	640	THR	4.5
1	A	661	ALA	4.4
1	G	645	TRP	4.3
1	G	657	LEU	4.2

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. 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($\text{\AA}^2$)	Q<0.9
3	1WA	I	205	22/23	0.91	0.10	33,39,46,56	0
2	1W5	H	112	22/23	0.93	0.10	28,34,41,45	0
3	1WA	D	205	22/23	0.95	0.08	29,35,41,43	0
2	1W5	B	112	22/23	0.95	0.09	26,31,40,45	0
3	1WA	F	205	22/23	0.96	0.07	31,36,41,43	0
2	1W5	E	112	22/23	0.96	0.07	28,32,35,39	0

6.3 Carbohydrates [i](#)

There are no oligosaccharides in this entry.

6.4 Ligands [i](#)

There are no ligands in this entry.

6.5 Other polymers [i](#)

There are no such residues in this entry.