



# Full wwPDB X-ray Structure Validation Report ⓘ

Jun 12, 2024 – 02:56 PM EDT

PDB ID : 3NGX  
Title : Crystal structure of bifunctional 5,10-methylenetetrahydrofolate dehydrogenase / cyclohydrolase from *Thermoplasma acidophilum*  
Authors : Hwang, K.W.; Sung, M.W.; Lee, W.H.  
Deposited on : 2010-06-14  
Resolution : 2.30 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](mailto: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>.

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

MolProbity : 4.02b-467  
Xtriage (Phenix) : 1.20.1  
EDS : 2.36.2  
Percentile statistics : 20191225.v01 (using entries in the PDB archive December 25th 2019)  
Refmac : 5.8.0158  
CCP4 : 7.0.044 (Gargrove)  
Ideal geometry (proteins) : Engh & Huber (2001)  
Ideal geometry (DNA, RNA) : Parkinson et al. (1996)  
Validation Pipeline (wwPDB-VP) : 2.36.2

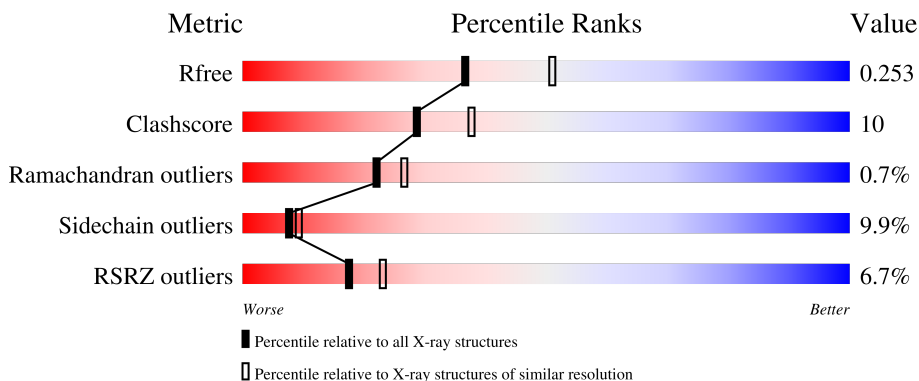
# 1 Overall quality at a glance

The following experimental techniques were used to determine the structure:

*X-RAY DIFFRACTION*

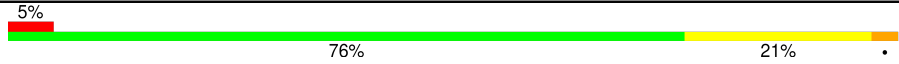
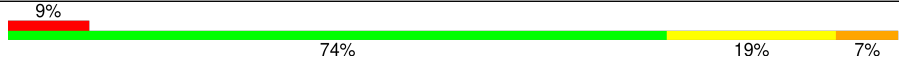
The reported resolution of this entry is 2.30 Å.

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))
$R_{free}$	130704	5042 (2.30-2.30)
Clashscore	141614	5643 (2.30-2.30)
Ramachandran outliers	138981	5575 (2.30-2.30)
Sidechain outliers	138945	5575 (2.30-2.30)
RSRZ outliers	127900	4938 (2.30-2.30)

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  $\geq 3$ , 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	276	
1	B	276	

## 2 Entry composition

There are 2 unique types of molecules in this entry. The entry contains 4399 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 Bifunctional protein fold.

Mol	Chain	Residues	Atoms					ZeroOcc	AltConf	Trace
			Total	C	N	O	S			
1	A	275	2143	1360	368	407	8	0	0	0
1	B	275	2143	1360	368	407	8	0	0	0

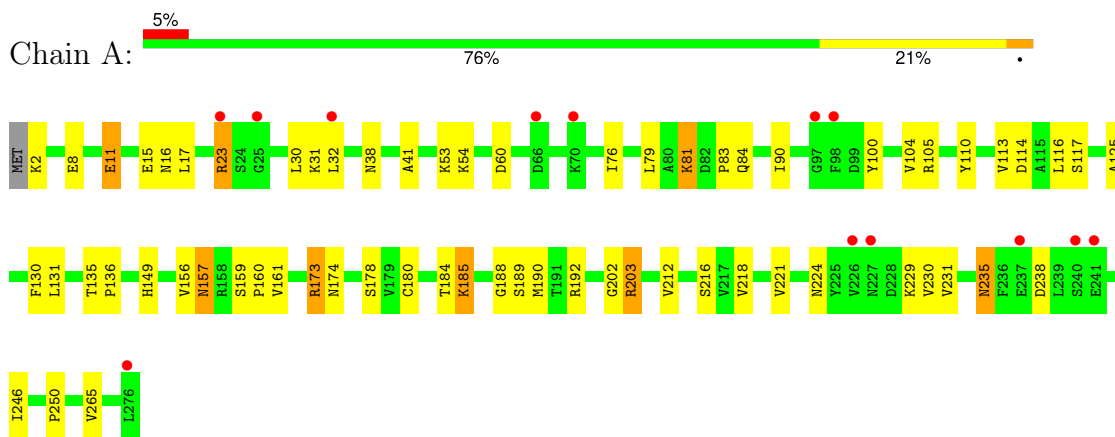
- Molecule 2 is water.

Mol	Chain	Residues	Atoms		ZeroOcc	AltConf
2	A	63	Total	O	0	0
			63	63		
2	B	50	Total	O	0	0
			50	50		

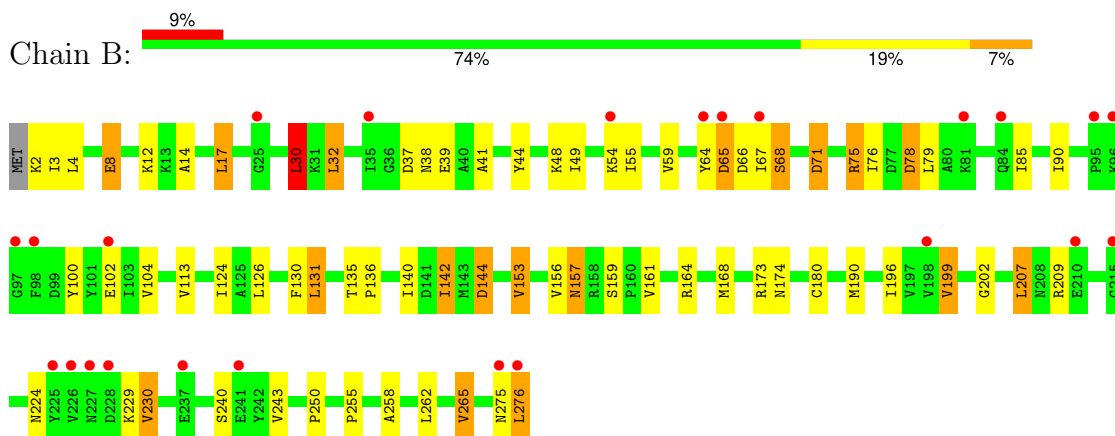
### 3 Residue-property plots [i](#)

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: Bifunctional protein fold



- Molecule 1: Bifunctional protein fold



## 4 Data and refinement statistics

Property	Value	Source
Space group	P 1 21 1	Depositor
Cell constants a, b, c, $\alpha$ , $\beta$ , $\gamma$	66.42Å 52.92Å 86.03Å 90.00° 97.77° 90.00°	Depositor
Resolution (Å)	29.39 – 2.30 29.39 – 2.30	Depositor EDS
% Data completeness (in resolution range)	96.3 (29.39-2.30) 96.3 (29.39-2.30)	Depositor EDS
$R_{merge}$	(Not available)	Depositor
$R_{sym}$	(Not available)	Depositor
$\langle I/\sigma(I) \rangle$ <sup>1</sup>	3.07 (at 2.31Å)	Xtrriage
Refinement program	REFMAC 5.5.0109	Depositor
R, $R_{free}$	0.189 , 0.256 0.187 , 0.253	Depositor DCC
$R_{free}$ test set	1283 reflections (5.01%)	wwPDB-VP
Wilson B-factor (Å <sup>2</sup> )	30.3	Xtrriage
Anisotropy	0.062	Xtrriage
Bulk solvent $k_{sol}$ (e/Å <sup>3</sup> ), $B_{sol}$ (Å <sup>2</sup> )	0.39 , 53.3	EDS
L-test for twinning <sup>2</sup>	$\langle  L  \rangle = 0.49$ , $\langle L^2 \rangle = 0.32$	Xtrriage
Estimated twinning fraction	No twinning to report.	Xtrriage
$F_o, F_c$ correlation	0.95	EDS
Total number of atoms	4399	wwPDB-VP
Average B, all atoms (Å <sup>2</sup> )	32.0	wwPDB-VP

Xtrriage's analysis on translational NCS is as follows: *The largest off-origin peak in the Patterson function is 5.73% of the height of the origin peak. No significant pseudotranslation is detected.*

<sup>1</sup>Intensities estimated from amplitudes.

<sup>2</sup>Theoretical 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](#)

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	0.92	2/2178 (0.1%)	0.91	1/2951 (0.0%)
1	B	0.85	1/2178 (0.0%)	0.90	3/2951 (0.1%)
All	All	0.89	3/4356 (0.1%)	0.90	4/5902 (0.1%)

All (3) bond length outliers are listed below:

Mol	Chain	Res	Type	Atoms	Z	Observed(Å)	Ideal(Å)
1	B	180	CYS	CB-SG	-6.51	1.71	1.82
1	A	180	CYS	CB-SG	-5.83	1.72	1.81
1	A	11	GLU	CB-CG	5.43	1.62	1.52

All (4) bond angle outliers are listed below:

Mol	Chain	Res	Type	Atoms	Z	Observed(°)	Ideal(°)
1	B	199	VAL	CB-CA-C	-6.59	98.87	111.40
1	B	30	LEU	CA-CB-CG	5.61	128.20	115.30
1	B	207	LEU	CA-CB-CG	5.30	127.48	115.30
1	A	173	ARG	NE-CZ-NH1	5.17	122.88	120.30

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	2143	0	2195	43	0

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Mol	Chain	Non-H	H(model)	H(added)	Clashes	Symm-Clashes
1	B	2143	0	2195	43	0
2	A	63	0	0	2	0
2	B	50	0	0	1	0
All	All	4399	0	4390	84	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 10.

All (84) 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:B:75:ARG:HG2	1:B:75:ARG:HH11	0.95	1.11
1:A:185:LYS:HE2	1:A:185:LYS:H	1.23	1.02
1:A:185:LYS:H	1:A:185:LYS:CE	1.75	0.99
1:B:75:ARG:HG2	1:B:75:ARG:NH1	1.75	0.92
1:B:75:ARG:HH11	1:B:75:ARG:CG	1.85	0.86
1:A:203:ARG:HH11	1:A:203:ARG:HG2	1.40	0.86
1:A:38:ASN:HD22	1:A:41:ALA:H	1.29	0.81
1:A:31:LYS:NZ	1:A:60:ASP:OD2	2.14	0.79
1:A:185:LYS:HE2	1:A:185:LYS:N	1.98	0.78
1:A:203:ARG:HH11	1:A:203:ARG:CG	2.01	0.74
1:A:149:HIS:HE1	2:A:283:HOH:O	1.70	0.73
1:B:262:LEU:HA	1:B:265:VAL:HG23	1.75	0.69
1:A:30:LEU:HD22	1:A:265:VAL:HG21	1.74	0.67
1:A:203:ARG:HG2	1:A:203:ARG:NH1	2.06	0.67
1:A:135:THR:HB	1:A:136:PRO:HD3	1.78	0.64
1:B:38:ASN:HD22	1:B:41:ALA:H	1.46	0.61
1:A:38:ASN:ND2	1:A:41:ALA:H	1.97	0.61
1:A:235:ASN:ND2	1:A:238:ASP:H	2.02	0.58
1:B:255:PRO:HD3	2:B:303:HOH:O	2.04	0.57
1:A:230:VAL:HG13	1:A:250:PRO:HG3	1.87	0.57
1:A:81:LYS:O	1:A:83:PRO:HD3	2.05	0.56
1:A:202:GLY:HA2	1:A:224:ASN:HD21	1.70	0.56
1:B:39:GLU:OE1	1:B:39:GLU:HA	2.06	0.56
1:B:14:ALA:HB1	1:B:55:ILE:HD11	1.89	0.55
1:B:202:GLY:HA2	1:B:224:ASN:HD21	1.71	0.54
1:A:100:TYR:CZ	1:A:104:VAL:HG21	2.43	0.54
1:B:76:ILE:HD11	1:B:90:ILE:HD11	1.90	0.53
1:B:4:LEU:HD13	1:B:142:ILE:CD1	2.37	0.53
1:A:173:ARG:O	1:A:174:ASN:HB2	2.09	0.53
1:A:230:VAL:CG1	1:A:250:PRO:HG3	2.39	0.52

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Atom-1	Atom-2	Interatomic distance (Å)	Clash overlap (Å)
1:A:160:PRO:HB3	1:B:126:LEU:HD23	1.91	0.52
1:B:100:TYR:CZ	1:B:104:VAL:HG21	2.45	0.52
1:B:38:ASN:ND2	1:B:41:ALA:H	2.09	0.51
1:B:142:ILE:C	1:B:142:ILE:HD12	2.30	0.51
1:A:218:VAL:HG22	1:A:246:ILE:HG13	1.92	0.51
1:A:31:LYS:HG3	1:A:79:LEU:HD22	1.93	0.50
1:A:125:ALA:O	1:B:164:ARG:HD3	2.12	0.49
1:B:230:VAL:HG22	1:B:250:PRO:HG3	1.95	0.49
1:B:202:GLY:CA	1:B:224:ASN:HD21	2.25	0.49
1:B:113:VAL:HG11	1:B:265:VAL:HG13	1.95	0.49
1:B:68:SER:HB2	1:B:71:ASP:OD1	2.13	0.48
1:A:212:VAL:HB	1:A:216:SER:OG	2.13	0.48
1:A:178:SER:HB3	1:A:190:MET:HE2	1.96	0.48
1:A:221:VAL:HG12	1:A:221:VAL:O	2.13	0.47
1:B:140:ILE:O	1:B:144:ASP:HB2	2.15	0.47
1:A:235:ASN:HD22	1:A:238:ASP:H	1.61	0.47
1:B:124:ILE:HG22	1:B:168:MET:HB2	1.97	0.47
1:A:184:THR:HA	1:A:185:LYS:HE2	1.97	0.47
1:A:104:VAL:HG13	1:A:117:SER:HB3	1.97	0.47
1:A:202:GLY:CA	1:A:224:ASN:HD21	2.27	0.47
1:B:75:ARG:HA	1:B:78:ASP:HB2	1.97	0.47
1:B:275:ASN:O	1:B:276:LEU:HB2	2.16	0.46
1:A:30:LEU:HD22	1:A:265:VAL:CG2	2.43	0.46
1:B:135:THR:HB	1:B:136:PRO:HD3	1.98	0.46
1:B:4:LEU:HD13	1:B:142:ILE:HD11	1.98	0.46
1:A:156:VAL:O	1:A:157:ASN:HB2	2.17	0.45
1:B:44:TYR:O	1:B:48:LYS:HG3	2.16	0.45
1:B:48:LYS:HG2	1:B:258:ALA:HB1	1.99	0.45
1:B:156:VAL:O	1:B:157:ASN:HB2	2.16	0.45
1:B:79:LEU:HD22	1:B:85:ILE:HD13	1.99	0.45
1:B:8:GLU:O	1:B:12:LYS:HG3	2.17	0.45
1:A:113:VAL:HG11	1:A:265:VAL:HG22	1.98	0.45
1:A:76:ILE:HD11	1:A:90:ILE:HD11	1.98	0.44
1:A:188:GLY:O	1:A:192:ARG:HG3	2.17	0.44
1:B:30:LEU:HB2	1:B:265:VAL:HG11	1.99	0.44
1:A:23:ARG:NH1	2:A:303:HOH:O	2.49	0.44
1:B:32:LEU:HD11	1:B:48:LYS:HZ2	1.83	0.44
1:A:110:TYR:HA	1:A:130:PHE:HE2	1.83	0.43
1:A:178:SER:HB3	1:A:190:MET:CE	2.48	0.43
1:B:2:LYS:HE2	1:B:2:LYS:HB2	1.70	0.43
1:B:75:ARG:NH1	1:B:75:ARG:CG	2.56	0.43

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Atom-1	Atom-2	Interatomic distance (Å)	Clash overlap (Å)
1:B:65:ASP:OD1	1:B:65:ASP:N	2.45	0.43
1:B:49:ILE:HA	1:B:59:VAL:HB	1.99	0.43
1:B:153:VAL:HB	1:B:196:ILE:HB	2.01	0.43
1:A:11:GLU:O	1:A:15:GLU:HG3	2.19	0.42
1:B:14:ALA:CB	1:B:55:ILE:HD11	2.50	0.42
1:A:17:LEU:HD12	1:A:17:LEU:HA	1.93	0.42
1:A:221:VAL:O	1:A:221:VAL:CG1	2.67	0.41
1:A:159:SER:OG	1:A:161:VAL:HG12	2.20	0.41
1:A:8:GLU:H	1:A:8:GLU:HG2	1.55	0.41
1:B:130:PHE:CE2	1:B:131:LEU:HD22	2.56	0.41
1:B:17:LEU:HD12	1:B:17:LEU:HA	1.96	0.41
1:B:173:ARG:O	1:B:174:ASN:HB2	2.22	0.40
1:B:64:TYR:OH	1:B:75:ARG:HD2	2.20	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	
1	A	273/276 (99%)	257 (94%)	15 (6%)	1 (0%)	34	42
1	B	273/276 (99%)	257 (94%)	13 (5%)	3 (1%)	14	15
All	All	546/552 (99%)	514 (94%)	28 (5%)	4 (1%)	22	26

All (4) Ramachandran outliers are listed below:

Mol	Chain	Res	Type
1	A	157	ASN
1	B	157	ASN
1	B	54	LYS
1	B	229	LYS

### 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	237/238 (100%)	219 (92%)	18 (8%)	13	16
1	B	237/238 (100%)	208 (88%)	29 (12%)	5	5
All	All	474/476 (100%)	427 (90%)	47 (10%)	8	9

All (47) residues with a non-rotameric sidechain are listed below:

Mol	Chain	Res	Type
1	A	2	LYS
1	A	16	ASN
1	A	23	ARG
1	A	32	LEU
1	A	53	LYS
1	A	54	LYS
1	A	81	LYS
1	A	84	GLN
1	A	105	ARG
1	A	114	ASP
1	A	116	LEU
1	A	131	LEU
1	A	185	LYS
1	A	189	SER
1	A	203	ARG
1	A	229	LYS
1	A	231	VAL
1	A	235	ASN
1	B	3	ILE
1	B	8	GLU
1	B	17	LEU
1	B	30	LEU
1	B	32	LEU
1	B	37	ASP
1	B	65	ASP
1	B	66	ASP
1	B	67	ILE

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Mol	Chain	Res	Type
1	B	68	SER
1	B	71	ASP
1	B	75	ARG
1	B	78	ASP
1	B	102	GLU
1	B	131	LEU
1	B	142	ILE
1	B	144	ASP
1	B	153	VAL
1	B	159	SER
1	B	161	VAL
1	B	190	MET
1	B	199	VAL
1	B	207	LEU
1	B	209	ARG
1	B	230	VAL
1	B	240	SER
1	B	243	VAL
1	B	265	VAL
1	B	276	LEU

Sometimes sidechains can be flipped to improve hydrogen bonding and reduce clashes. All (10) such sidechains are listed below:

Mol	Chain	Res	Type
1	A	38	ASN
1	A	149	HIS
1	A	151	ASN
1	A	224	ASN
1	A	235	ASN
1	B	16	ASN
1	B	38	ASN
1	B	92	ASN
1	B	121	GLN
1	B	224	ASN

### 5.3.3 RNA [i](#)

There are no RNA molecules in this entry.

#### 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 monosaccharides 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](#)

There are no chain breaks in this entry.

## 6 Fit of model and data

### 6.1 Protein, DNA and RNA chains

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, 95<sup>th</sup> 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 <sup>2</sup> )	Q<0.9
1	A	275/276 (99%)	0.29	13 (4%) 31 38	10, 25, 51, 55	0
1	B	275/276 (99%)	0.48	24 (8%) 10 14	15, 32, 60, 72	0
All	All	550/552 (99%)	0.38	37 (6%) 17 23	10, 29, 55, 72	0

All (37) RSRZ outliers are listed below:

Mol	Chain	Res	Type	RSRZ
1	B	97	GLY	6.5
1	B	96	LYS	5.1
1	B	276	LEU	4.9
1	A	226	VAL	4.3
1	B	98	PHE	4.2
1	A	70	LYS	3.6
1	A	276	LEU	3.5
1	A	240	SER	3.4
1	A	25	GLY	3.1
1	A	98	PHE	3.1
1	B	67	ILE	3.0
1	B	95	PRO	3.0
1	B	237	GLU	3.0
1	B	226	VAL	3.0
1	B	25	GLY	2.9
1	A	23	ARG	2.9
1	A	97	GLY	2.8
1	B	227	ASN	2.7
1	B	198	VAL	2.6
1	B	225	TYR	2.6
1	A	66	ASP	2.6
1	B	241	GLU	2.6
1	A	237	GLU	2.5
1	B	215	GLY	2.5

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Mol	Chain	Res	Type	RSRZ
1	B	102	GLU	2.3
1	B	81	LYS	2.3
1	A	32	LEU	2.3
1	B	84	GLN	2.2
1	B	65	ASP	2.2
1	A	227	ASN	2.2
1	B	210	GLU	2.2
1	B	54	LYS	2.1
1	B	228	ASP	2.1
1	B	64	TYR	2.1
1	B	275	ASN	2.0
1	A	241	GLU	2.0
1	B	35	ILE	2.0

## 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 monosaccharides 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.