



Full wwPDB X-ray Structure Validation Report ⓘ

Mar 8, 2026 – 12:59 PM UTC

PDB ID : 2XGG / pdb_00002xgg
Title : Structure of Toxoplasma gondii Micronemal Protein 2 A_I Domain
Authors : Tonkin, M.L.; Grujic, O.; Pearce, M.; Crawford, J.; Boulanger, M.J.
Deposited on : 2010-06-03
Resolution : 2.05 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

<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

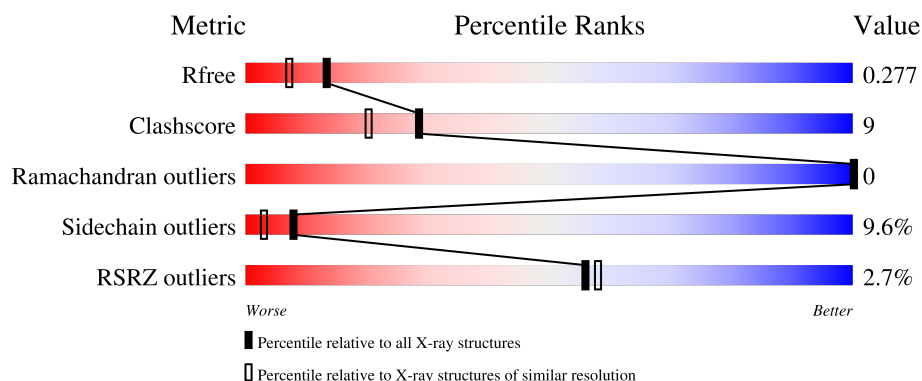
1 Overall quality at a glance

The following experimental techniques were used to determine the structure:

X-RAY DIFFRACTION

The reported resolution of this entry is 2.05 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	2260 (2.04-2.04)
Clashscore	190562	2333 (2.04-2.04)
Ramachandran outliers	187476	2318 (2.04-2.04)
Sidechain outliers	187428	2318 (2.04-2.04)
RSRZ outliers	180081	2260 (2.04-2.04)

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	178	2% 63% 16% • 17%
1	B	178	2% 61% 18% •• 17%

2 Entry composition

There are 3 unique types of molecules in this entry. The entry contains 2361 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 MICRONEME PROTEIN 2.

Mol	Chain	Residues	Atoms					ZeroOcc	AltConf	Trace
1	A	147	Total	C	N	O	S	0	0	0
			1122	708	195	214	5			
1	B	148	Total	C	N	O	S	0	0	0
			1130	713	196	215	6			

There are 58 discrepancies between the modelled and reference sequences:

Chain	Residue	Modelled	Actual	Comment	Reference
A	58	ALA	-	expression tag	UNP B6KIP6
A	59	ASP	-	expression tag	UNP B6KIP6
A	60	LEU	-	expression tag	UNP B6KIP6
A	61	GLY	-	expression tag	UNP B6KIP6
A	62	SER	-	expression tag	UNP B6KIP6
A	63	LEU	-	expression tag	UNP B6KIP6
A	64	VAL	-	expression tag	UNP B6KIP6
A	65	PRO	-	expression tag	UNP B6KIP6
A	66	ARG	-	expression tag	UNP B6KIP6
A	67	GLY	-	expression tag	UNP B6KIP6
A	68	SER	-	expression tag	UNP B6KIP6
A	69	ALA	-	expression tag	UNP B6KIP6
A	70	MET	-	expression tag	UNP B6KIP6
A	71	GLY	-	expression tag	UNP B6KIP6
A	221	ALA	-	expression tag	UNP B6KIP6
A	222	ALA	-	expression tag	UNP B6KIP6
A	223	ALA	-	expression tag	UNP B6KIP6
A	224	LEU	-	expression tag	UNP B6KIP6
A	225	VAL	-	expression tag	UNP B6KIP6
A	226	PRO	-	expression tag	UNP B6KIP6
A	227	ARG	-	expression tag	UNP B6KIP6
A	228	GLY	-	expression tag	UNP B6KIP6
A	229	SER	-	expression tag	UNP B6KIP6
A	230	HIS	-	expression tag	UNP B6KIP6
A	231	HIS	-	expression tag	UNP B6KIP6

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Chain	Residue	Modelled	Actual	Comment	Reference
A	232	HIS	-	expression tag	UNP B6KIP6
A	233	HIS	-	expression tag	UNP B6KIP6
A	234	HIS	-	expression tag	UNP B6KIP6
A	235	HIS	-	expression tag	UNP B6KIP6
B	58	ALA	-	expression tag	UNP B6KIP6
B	59	ASP	-	expression tag	UNP B6KIP6
B	60	LEU	-	expression tag	UNP B6KIP6
B	61	GLY	-	expression tag	UNP B6KIP6
B	62	SER	-	expression tag	UNP B6KIP6
B	63	LEU	-	expression tag	UNP B6KIP6
B	64	VAL	-	expression tag	UNP B6KIP6
B	65	PRO	-	expression tag	UNP B6KIP6
B	66	ARG	-	expression tag	UNP B6KIP6
B	67	GLY	-	expression tag	UNP B6KIP6
B	68	SER	-	expression tag	UNP B6KIP6
B	69	ALA	-	expression tag	UNP B6KIP6
B	70	MET	-	expression tag	UNP B6KIP6
B	71	GLY	-	expression tag	UNP B6KIP6
B	221	ALA	-	expression tag	UNP B6KIP6
B	222	ALA	-	expression tag	UNP B6KIP6
B	223	ALA	-	expression tag	UNP B6KIP6
B	224	LEU	-	expression tag	UNP B6KIP6
B	225	VAL	-	expression tag	UNP B6KIP6
B	226	PRO	-	expression tag	UNP B6KIP6
B	227	ARG	-	expression tag	UNP B6KIP6
B	228	GLY	-	expression tag	UNP B6KIP6
B	229	SER	-	expression tag	UNP B6KIP6
B	230	HIS	-	expression tag	UNP B6KIP6
B	231	HIS	-	expression tag	UNP B6KIP6
B	232	HIS	-	expression tag	UNP B6KIP6
B	233	HIS	-	expression tag	UNP B6KIP6
B	234	HIS	-	expression tag	UNP B6KIP6
B	235	HIS	-	expression tag	UNP B6KIP6

- Molecule 2 is GLYCEROL (CCD ID: GOL) (formula: $C_3H_8O_3$).



Mol	Chain	Residues	Atoms			ZeroOcc	AltConf
2	A	1	Total	C	O	0	0
			6	3	3		

- Molecule 3 is water.

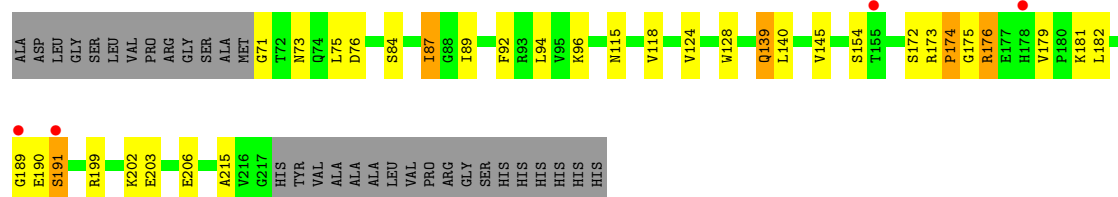
Mol	Chain	Residues	Atoms		ZeroOcc	AltConf
3	A	39	Total	O	0	0
			39	39		
3	B	64	Total	O	0	0
			64	64		

3 Residue-property plots

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.

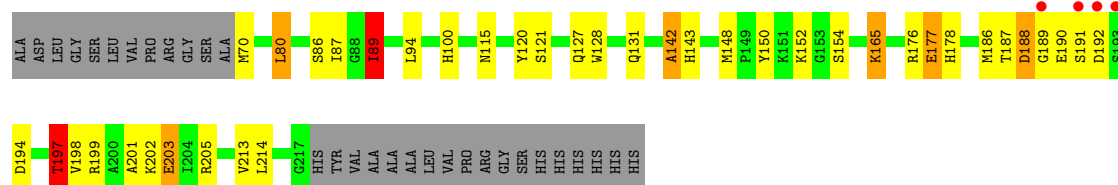
• Molecule 1: MICRONEME PROTEIN 2

Chain A: 



• Molecule 1: MICRONEME PROTEIN 2

Chain B: 



4 Data and refinement statistics

Property	Value	Source
Space group	P 43 21 2	Depositor
Cell constants a, b, c, α , β , γ	63.03Å 63.03Å 157.63Å 90.00° 90.00° 90.00°	Depositor
Resolution (Å)	24.84 – 2.05 24.84 – 2.05	Depositor EDS
% Data completeness (in resolution range)	100.0 (24.84-2.05) 99.9 (24.84-2.05)	Depositor EDS
R_{merge}	0.06	Depositor
R_{sym}	(Not available)	Depositor
$\langle I/\sigma(I) \rangle$ ¹	5.81 (at 2.04Å)	Xtriage
Refinement program	REFMAC 5.5.0088	Depositor
R, R_{free}	0.206 , 0.278 0.216 , 0.277	Depositor DCC
R_{free} test set	1065 reflections (5.13%)	wwPDB-VP
Wilson B-factor (Å ²)	43.4	Xtriage
Anisotropy	0.002	Xtriage
Bulk solvent k_{sol} (e/Å ³), B_{sol} (Å ²)	0.36 , 41.6	EDS
L-test for twinning ²	$\langle L \rangle = 0.52$, $\langle L^2 \rangle = 0.35$	Xtriage
Estimated twinning fraction	No twinning to report.	Xtriage
F_o, F_c correlation	0.95	EDS
Total number of atoms	2361	wwPDB-VP
Average B, all atoms (Å ²)	43.0	wwPDB-VP

Xtriage's analysis on translational NCS is as follows: *The largest off-origin peak in the Patterson function is 5.70% 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

5.1 Standard geometry

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

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	1.17	1/1141 (0.1%)	1.14	1/1546 (0.1%)
1	B	1.42	3/1149 (0.3%)	1.37	14/1556 (0.9%)
All	All	1.30	4/2290 (0.2%)	1.26	15/3102 (0.5%)

Chiral center outliers are detected by calculating the chiral volume of a chiral center and verifying if the center is modelled as a planar moiety or with the opposite hand. A planarity outlier is detected by checking planarity of atoms in a peptide group, atoms in a mainchain group or atoms of a sidechain that are expected to be planar.

Mol	Chain	#Chirality outliers	#Planarity outliers
1	A	0	1

All (4) bond length outliers are listed below:

Mol	Chain	Res	Type	Atoms	Z	Observed(Å)	Ideal(Å)
1	B	142	ALA	CA-CB	6.21	1.62	1.53
1	B	87	ILE	CA-CB	5.54	1.60	1.54
1	A	145	VAL	CA-CB	5.36	1.61	1.54
1	B	89	ILE	CA-CB	5.03	1.60	1.54

All (15) bond angle outliers are listed below:

Mol	Chain	Res	Type	Atoms	Z	Observed(°)	Ideal(°)
1	B	188	ASP	CB-CA-C	-8.62	97.21	110.92
1	B	87	ILE	N-CA-C	7.98	118.08	110.42
1	B	89	ILE	CB-CA-C	-7.07	102.78	112.04
1	B	148	MET	CA-C-N	-6.91	112.81	120.14
1	B	148	MET	C-N-CA	-6.91	112.81	120.14
1	B	89	ILE	N-CA-CB	6.78	118.95	110.47
1	B	187	THR	CA-C-N	6.21	129.42	120.79

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Mol	Chain	Res	Type	Atoms	Z	Observed(°)	Ideal(°)
1	B	187	THR	C-N-CA	6.21	129.42	120.79
1	B	152	LYS	N-CA-C	5.76	118.22	111.02
1	B	176	ARG	CB-CG-CD	5.44	123.81	111.30
1	B	176	ARG	CA-CB-CG	-5.43	103.24	114.10
1	B	197	THR	N-CA-C	5.28	119.95	112.93
1	B	127	GLN	N-CA-C	-5.21	104.53	112.04
1	A	176	ARG	N-CA-C	-5.03	105.62	112.26
1	B	189	GLY	N-CA-C	-5.00	108.07	114.37

There are no chirality outliers.

All (1) planarity outliers are listed below:

Mol	Chain	Res	Type	Group
1	A	174	PRO	Peptide

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	1122	0	1130	16	0
1	B	1130	0	1139	26	0
2	A	6	0	8	0	0
3	A	39	0	0	2	0
3	B	64	0	0	2	0
All	All	2361	0	2277	40	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 9.

All (40) 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:165:LYS:HD3	1:B:203:GLU:OE2	1.20	1.31
1:A:189:GLY:HA2	1:A:215:ALA:HB1	1.41	1.01
1:A:189:GLY:HA2	1:A:215:ALA:CB	1.95	0.96

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Atom-1	Atom-2	Interatomic distance (Å)	Clash overlap (Å)
1:B:165:LYS:CD	1:B:203:GLU:OE2	2.15	0.94
1:B:165:LYS:HD3	1:B:203:GLU:CD	1.97	0.89
1:B:188:ASP:HB3	1:B:190:GLU:H	1.41	0.86
1:A:189:GLY:CA	1:A:215:ALA:HB1	2.11	0.81
1:A:92:PHE:CE1	1:A:96:LYS:HD2	2.19	0.78
1:A:71:GLY:N	3:A:2001:HOH:O	2.25	0.69
1:B:80:LEU:HD22	1:B:120:TYR:CD2	2.30	0.66
1:B:201:ALA:O	1:B:205:ARG:HG3	1.96	0.65
1:B:192:ASP:C	1:B:192:ASP:OD1	2.40	0.64
1:B:186:MET:HE2	1:B:214:LEU:HD12	1.85	0.59
1:B:70:MET:HA	1:B:178:HIS:HD2	1.66	0.59
1:A:139:GLN:HB3	3:A:2018:HOH:O	2.02	0.59
1:A:173:ARG:HB3	1:A:174:PRO:HD2	1.85	0.57
1:B:199:ARG:NH1	1:B:202:LYS:HE2	2.19	0.56
1:A:115:ASN:ND2	1:A:128:TRP:HE1	2.04	0.56
1:A:73:ASN:HD21	1:B:213:VAL:H	1.56	0.52
1:A:73:ASN:ND2	1:B:213:VAL:H	2.08	0.50
1:B:192:ASP:OD1	1:B:192:ASP:O	2.30	0.48
1:A:176:ARG:O	1:A:179:VAL:HG22	2.14	0.48
1:A:84:SER:O	1:A:87:ILE:HG23	2.13	0.47
1:A:203:GLU:HA	1:A:206:GLU:HG2	1.96	0.47
1:B:194:ASP:O	1:B:198:VAL:HG22	2.15	0.47
1:B:115:ASN:ND2	1:B:128:TRP:HE1	2.13	0.46
1:B:188:ASP:CB	1:B:190:GLU:H	2.21	0.45
1:B:80:LEU:HD22	1:B:120:TYR:HD2	1.82	0.43
1:B:197:THR:HG21	3:B:2055:HOH:O	2.18	0.43
1:B:199:ARG:HH11	1:B:202:LYS:HE2	1.83	0.43
1:B:121:SER:C	1:B:154:SER:O	2.62	0.43
1:B:70:MET:HA	1:B:178:HIS:CD2	2.51	0.42
1:B:197:THR:HG22	1:B:198:VAL:N	2.34	0.42
1:B:89:ILE:HG23	1:B:150:TYR:CD2	2.55	0.41
1:A:174:PRO:HA	1:A:175:GLY:HA2	1.90	0.41
1:B:177:GLU:H	1:B:177:GLU:CD	2.28	0.41
1:B:143:HIS:HD2	3:B:2030:HOH:O	2.03	0.40
1:A:76:ASP:OD2	1:A:181:LYS:NZ	2.53	0.40
1:A:190:GLU:O	1:A:191:SER:CB	2.67	0.40
1:B:100:HIS:HD2	1:B:142:ALA:O	2.04	0.40

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	145/178 (82%)	136 (94%)	9 (6%)	0	100	100
1	B	146/178 (82%)	137 (94%)	9 (6%)	0	100	100
All	All	291/356 (82%)	273 (94%)	18 (6%)	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	
1	A	125/148 (84%)	111 (89%)	14 (11%)	6	1
1	B	126/148 (85%)	116 (92%)	10 (8%)	11	5
All	All	251/296 (85%)	227 (90%)	24 (10%)	8	3

All (24) residues with a non-rotameric sidechain are listed below:

Mol	Chain	Res	Type
1	A	75	LEU
1	A	87	ILE
1	A	89	ILE
1	A	94	LEU
1	A	118	VAL
1	A	124	VAL
1	A	139	GLN
1	A	140	LEU

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Mol	Chain	Res	Type
1	A	154	SER
1	A	172	SER
1	A	182	LEU
1	A	191	SER
1	A	199	ARG
1	A	202	LYS
1	B	80	LEU
1	B	86	SER
1	B	89	ILE
1	B	94	LEU
1	B	131	GLN
1	B	165	LYS
1	B	177	GLU
1	B	191	SER
1	B	197	THR
1	B	203	GLU

Sometimes sidechains can be flipped to improve hydrogen bonding and reduce clashes. All (8) such sidechains are listed below:

Mol	Chain	Res	Type
1	A	73	ASN
1	A	91	ASN
1	A	100	HIS
1	A	114	ASN
1	A	115	ASN
1	B	100	HIS
1	B	115	ASN
1	B	143	HIS

5.3.3 RNA ⓘ

There are no RNA molecules in this entry.

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

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

5.5 Carbohydrates ⓘ

There are no oligosaccharides in this entry.

5.6 Ligand geometry [i](#)

1 ligand 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
2	GOL	A	1218	-	5,5,5	0.53	0	5,5,5	0.46	0

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	GOL	A	1218	-	-	4/4/4/4	-

There are no bond length outliers.

There are no bond angle outliers.

There are no chirality outliers.

All (4) torsion outliers are listed below:

Mol	Chain	Res	Type	Atoms
2	A	1218	GOL	O1-C1-C2-C3
2	A	1218	GOL	C1-C2-C3-O3
2	A	1218	GOL	O1-C1-C2-O2
2	A	1218	GOL	O2-C2-C3-O3

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 ⓘ

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	147/178 (82%)	0.37	4 (2%) 56 58	27, 46, 68, 74	6 (4%)
1	B	148/178 (83%)	0.03	4 (2%) 56 58	27, 35, 55, 75	14 (9%)
All	All	295/356 (82%)	0.20	8 (2%) 56 58	27, 41, 67, 75	20 (6%)

All (8) RSRZ outliers are listed below:

Mol	Chain	Res	Type	RSRZ
1	A	191	SER	7.4
1	B	191	SER	5.5
1	A	189	GLY	4.6
1	B	189	GLY	3.4
1	B	193	SER	2.5
1	A	178	HIS	2.5
1	B	192	ASP	2.1
1	A	155	THR	2.1

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($\text{\AA}^2$)	Q<0.9
2	GOL	A	1218	6/6	0.81	0.15	62,66,68,70	0

6.5 Other polymers [i](#)

There are no such residues in this entry.