



Full wwPDB X-ray Structure Validation Report ⓘ

Mar 20, 2026 – 12:04 PM UTC

PDB ID : 1E89 / pdb_00001e89
Title : ON THE MECHANISM OF CYANOGENESIS CATALYZED BY HYDROXYNITRILE LYASE FROM MANIHOT ESCULENTA. CRYSTAL STRUCTURE OF ACTIVE SITE MUTANT SER80ALA IN COMPLEX WITH ACETONE CYANOHYDRIN
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Deposited on : 2000-09-18
Resolution : 2.10 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
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

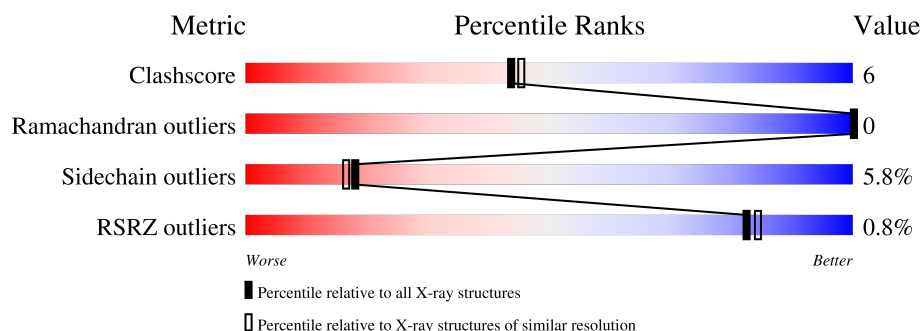
1 Overall quality at a glance

The following experimental techniques were used to determine the structure:

X-RAY DIFFRACTION

The reported resolution of this entry is 2.10 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))
Clashscore	190562	7164 (2.10-2.10)
Ramachandran outliers	187476	7099 (2.10-2.10)
Sidechain outliers	187428	7100 (2.10-2.10)
RSRZ outliers	180081	6662 (2.10-2.10)

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	262	% 79% 15% • •
1	B	262	80% 14% • • •

2 Entry composition

There are 2 unique types of molecules in this entry. The entry contains 4602 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 HYDROXYNITRILE LYASE.

Mol	Chain	Residues	Atoms					ZeroOcc	AltConf	Trace
1	A	262	Total	C	N	O	S	0	0	0
			2103	1359	349	387	8			
1	B	258	Total	C	N	O	S	0	0	0
			2073	1339	344	382	8			

There are 2 discrepancies between the modelled and reference sequences:

Chain	Residue	Modelled	Actual	Comment	Reference
A	80	ALA	SER	engineered mutation	UNP P52705
B	80	ALA	SER	engineered mutation	UNP P52705

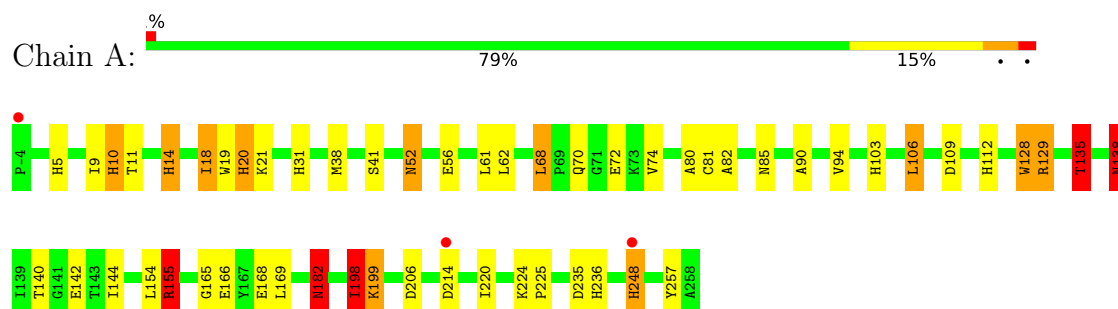
- Molecule 2 is water.

Mol	Chain	Residues	Atoms		ZeroOcc	AltConf
2	A	216	Total	O	0	0
			216	216		
2	B	210	Total	O	0	0
			210	210		

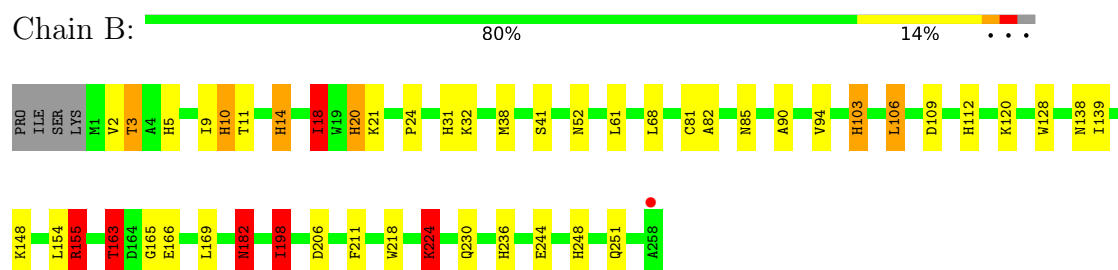
3 Residue-property plots [i](#)

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: HYDROXYNITRILE LYASE



• Molecule 1: HYDROXYNITRILE LYASE



4 Data and refinement statistics

Property	Value	Source
Space group	P 41 21 2	Depositor
Cell constants a, b, c, α , β , γ	106.18Å 106.18Å 188.15Å 90.00° 90.00° 90.00°	Depositor
Resolution (Å)	8.00 – 2.10 8.00 – 2.10	Depositor EDS
% Data completeness (in resolution range)	97.3 (8.00-2.10) 97.9 (8.00-2.10)	Depositor EDS
R_{merge}	(Not available)	Depositor
R_{sym}	0.07	Depositor
$\langle I/\sigma(I) \rangle$ ¹	7.51 (at 2.09Å)	Xtriage
Refinement program	X-PLOR 3.851	Depositor
R, R_{free}	0.180 , 0.219 0.180 , (Not available)	Depositor DCC
R_{free} test set	No test flags present.	wwPDB-VP
Wilson B-factor (Å ²)	21.7	Xtriage
Anisotropy	0.550	Xtriage
Bulk solvent k_{sol} (e/Å ³), B_{sol} (Å ²)	0.40 , 84.5	EDS
L-test for twinning ²	$\langle L \rangle = 0.50$, $\langle L^2 \rangle = 0.33$	Xtriage
Estimated twinning fraction	No twinning to report.	Xtriage
F_o, F_c correlation	0.95	EDS
Total number of atoms	4602	wwPDB-VP
Average B, all atoms (Å ²)	22.0	wwPDB-VP

Xtriage's analysis on translational NCS is as follows: *The largest off-origin peak in the Patterson function is 3.96% 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

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	1.07	13/2155 (0.6%)	1.61	27/2920 (0.9%)
1	B	1.06	9/2124 (0.4%)	1.63	31/2879 (1.1%)
All	All	1.06	22/4279 (0.5%)	1.62	58/5799 (1.0%)

All (22) bond length outliers are listed below:

Mol	Chain	Res	Type	Atoms	Z	Observed(Å)	Ideal(Å)
1	B	10	HIS	CD2-NE2	-7.60	1.29	1.37
1	A	31	HIS	CD2-NE2	-7.37	1.29	1.37
1	A	10	HIS	CD2-NE2	-6.91	1.30	1.37
1	A	20	HIS	CD2-NE2	-6.87	1.30	1.37
1	B	248	HIS	CD2-NE2	-6.72	1.30	1.37
1	A	112	HIS	CD2-NE2	-6.44	1.30	1.37
1	A	5	HIS	CD2-NE2	-6.30	1.30	1.37
1	B	5	HIS	CD2-NE2	-6.30	1.30	1.37
1	B	236	HIS	CD2-NE2	-6.13	1.31	1.37
1	B	31	HIS	CD2-NE2	-6.05	1.31	1.37
1	A	18	ILE	CA-CB	6.03	1.62	1.54
1	A	220	ILE	CA-CB	6.02	1.61	1.54
1	A	14	HIS	CD2-NE2	-5.99	1.31	1.37
1	B	103	HIS	CD2-NE2	-5.96	1.31	1.37
1	B	20	HIS	CD2-NE2	-5.75	1.31	1.37
1	A	248	HIS	CD2-NE2	-5.52	1.31	1.37
1	B	112	HIS	CD2-NE2	-5.42	1.31	1.37
1	A	236	HIS	CD2-NE2	-5.27	1.32	1.37
1	B	18	ILE	CB-CG1	-5.17	1.43	1.53
1	A	112	HIS	CG-ND1	-5.11	1.32	1.38
1	A	103	HIS	CD2-NE2	-5.03	1.32	1.37
1	A	20	HIS	CG-ND1	-5.00	1.32	1.38

All (58) bond angle outliers are listed below:

Mol	Chain	Res	Type	Atoms	Z	Observed(°)	Ideal(°)
1	B	198	ILE	CA-CB-CG1	-9.67	93.96	110.40
1	B	198	ILE	CA-CB-CG2	9.24	126.20	110.50
1	B	206	ASP	CA-CB-CG	8.21	120.81	112.60
1	A	198	ILE	CA-CB-CG2	7.88	123.90	110.50
1	A	198	ILE	CA-CB-CG1	-7.72	97.28	110.40
1	B	3	THR	N-CA-CB	-7.49	98.81	110.57
1	B	163	THR	N-CA-CB	-7.48	97.95	109.92
1	A	138	ASN	CA-CB-CG	7.35	119.95	112.60
1	A	31	HIS	CB-CG-CD2	-7.08	121.99	131.20
1	A	109	ASP	CA-CB-CG	7.05	119.66	112.60
1	B	155	ARG	NE-CZ-NH2	-6.77	113.11	119.20
1	B	3	THR	CB-CA-C	6.73	121.36	109.72
1	A	206	ASP	CA-CB-CG	6.65	119.25	112.60
1	A	236	HIS	CB-CG-CD2	-6.56	122.67	131.20
1	A	103	HIS	CB-CG-CD2	-6.51	122.74	131.20
1	B	109	ASP	CA-CB-CG	6.49	119.09	112.60
1	A	135	THR	N-CA-CB	-6.48	99.48	111.53
1	A	138	ASN	OD1-CG-ND2	-6.31	116.29	122.60
1	B	236	HIS	CB-CG-CD2	-6.26	123.06	131.20
1	A	155	ARG	NE-CZ-NH2	-6.25	113.58	119.20
1	B	103	HIS	CB-CG-CD2	-6.21	123.12	131.20
1	B	31	HIS	CB-CG-CD2	-6.08	123.29	131.20
1	B	18	ILE	N-CA-CB	5.99	123.63	111.05
1	B	198	ILE	CB-CG1-CD1	-5.96	101.28	113.80
1	A	52	ASN	OD1-CG-ND2	-5.94	116.66	122.60
1	A	248	HIS	CB-CG-CD2	-5.84	123.61	131.20
1	B	18	ILE	CB-CG1-CD1	-5.77	101.69	113.80
1	A	31	HIS	CB-CG-ND1	5.74	131.30	122.70
1	A	14	HIS	CB-CG-CD2	-5.70	123.78	131.20
1	B	18	ILE	CB-CA-C	-5.70	98.84	111.77
1	B	14	HIS	CB-CG-CD2	-5.67	123.83	131.20
1	B	230	GLN	OE1-CD-NE2	-5.66	116.94	122.60
1	B	3	THR	CA-CB-OG1	-5.66	101.11	109.60
1	B	182	ASN	CA-CB-CG	5.64	118.24	112.60
1	B	182	ASN	OD1-CG-ND2	-5.62	116.98	122.60
1	A	129	ARG	NE-CZ-NH2	-5.62	114.14	119.20
1	B	224	LYS	CA-C-N	5.61	125.60	120.21
1	B	224	LYS	C-N-CA	5.61	125.60	120.21
1	B	244	GLU	CB-CG-CD	5.57	122.07	112.60
1	B	198	ILE	N-CA-CB	-5.53	100.84	110.13
1	B	2	VAL	N-CA-C	-5.50	100.44	109.12
1	B	148	LYS	N-CA-C	-5.44	98.50	108.02
1	B	182	ASN	CB-CG-ND2	5.43	124.55	116.40

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Mol	Chain	Res	Type	Atoms	Z	Observed(°)	Ideal(°)
1	A	235	ASP	CA-CB-CG	5.43	118.03	112.60
1	A	68	LEU	CA-C-N	5.43	125.43	119.89
1	A	68	LEU	C-N-CA	5.43	125.43	119.89
1	A	236	HIS	CB-CG-ND1	5.40	130.80	122.70
1	A	70	GLN	OE1-CD-NE2	-5.40	117.20	122.60
1	A	199	LYS	CG-CD-CE	-5.33	99.05	111.30
1	B	21	LYS	N-CA-C	-5.22	106.59	113.12
1	B	20	HIS	CB-CG-CD2	-5.20	124.44	131.20
1	A	20	HIS	CB-CG-CD2	-5.16	124.50	131.20
1	A	248	HIS	CB-CG-ND1	5.11	130.37	122.70
1	A	19	TRP	CE2-CD2-CG	-5.11	101.07	107.20
1	A	182	ASN	OD1-CG-ND2	-5.10	117.50	122.60
1	B	251	GLN	OE1-CD-NE2	-5.09	117.50	122.60
1	B	236	HIS	CB-CG-ND1	5.04	130.25	122.70
1	A	128	TRP	CA-C-O	5.03	125.76	119.78

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	2103	0	2101	29	0
1	B	2073	0	2065	25	0
2	A	216	0	0	3	0
2	B	210	0	0	0	0
All	All	4602	0	4166	51	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 6.

All (51) 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:10:HIS:HE1	1:A:38:MET:H	1.19	0.88

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Atom-1	Atom-2	Interatomic distance (Å)	Clash overlap (Å)
1:B:10:HIS:HE1	1:B:38:MET:H	1.22	0.82
1:A:52:ASN:HD22	1:A:138:ASN:HB2	1.45	0.81
1:B:52:ASN:HD22	1:B:138:ASN:HB2	1.49	0.75
1:B:81:CYS:HA	1:B:106:LEU:HD22	1.69	0.74
1:A:10:HIS:HD2	1:A:11:THR:O	1.72	0.71
1:A:214:ASP:HB2	2:A:2098:HOH:O	1.93	0.69
1:B:10:HIS:HD2	1:B:11:THR:O	1.79	0.66
1:A:81:CYS:HA	1:A:106:LEU:HD22	1.81	0.63
1:A:199:LYS:HG2	1:A:257:TYR:CE1	2.34	0.63
1:A:182:ASN:HD22	1:A:182:ASN:H	1.47	0.62
1:A:168:GLU:HG2	1:B:24:PRO:HD3	1.82	0.61
1:A:82:ALA:HA	1:A:85:ASN:HD22	1.64	0.61
1:B:90:ALA:HB1	1:B:198:ILE:HD13	1.83	0.61
1:B:82:ALA:HA	1:B:85:ASN:HD22	1.67	0.59
1:A:248:HIS:HB3	2:A:2211:HOH:O	2.02	0.57
1:B:163:THR:HG22	1:B:166:GLU:H	1.71	0.56
1:A:138:ASN:ND2	1:A:142:GLU:H	2.03	0.56
1:B:94:VAL:HG23	1:B:198:ILE:HD11	1.88	0.55
1:B:20:HIS:HE1	1:B:166:GLU:OE1	1.90	0.54
1:B:94:VAL:HG23	1:B:198:ILE:CD1	2.37	0.54
1:A:56:GLU:HG2	2:A:2059:HOH:O	2.07	0.54
1:A:10:HIS:CE1	1:A:38:MET:H	2.11	0.53
1:A:182:ASN:HD22	1:A:182:ASN:N	2.07	0.53
1:A:20:HIS:HE1	1:A:166:GLU:OE1	1.93	0.52
1:A:135:THR:HA	1:A:144:ILE:O	2.09	0.52
1:A:155:ARG:HD3	1:A:155:ARG:O	2.10	0.52
1:A:68:LEU:HD11	1:A:74:VAL:HG13	1.92	0.50
1:B:182:ASN:H	1:B:182:ASN:HD22	1.59	0.50
1:A:94:VAL:HG23	1:A:198:ILE:HD12	1.95	0.49
1:A:155:ARG:HD3	1:A:155:ARG:C	2.36	0.49
1:A:20:HIS:HD2	1:B:165:GLY:O	1.98	0.47
1:B:10:HIS:CB	1:B:18:ILE:HD11	2.45	0.46
1:B:52:ASN:ND2	1:B:139:ILE:H	2.14	0.46
1:B:155:ARG:HA	1:B:155:ARG:HD3	1.65	0.46
1:B:14:HIS:O	1:B:41:SER:HB3	2.16	0.46
1:B:120:LYS:HG3	1:B:218:TRP:CH2	2.51	0.45
1:B:106:LEU:HD13	1:B:211:PHE:CE2	2.53	0.44
1:A:14:HIS:O	1:A:41:SER:HB3	2.18	0.44
1:B:224:LYS:H	1:B:224:LYS:NZ	2.15	0.44
1:A:138:ASN:ND2	1:A:140:THR:H	2.16	0.43
1:B:128:TRP:CD1	1:B:128:TRP:N	2.85	0.43

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Atom-1	Atom-2	Interatomic distance (Å)	Clash overlap (Å)
1:B:82:ALA:HA	1:B:85:ASN:ND2	2.32	0.43
1:A:128:TRP:N	1:A:128:TRP:CD1	2.88	0.42
1:A:165:GLY:O	1:B:20:HIS:HD2	2.03	0.42
1:A:9:ILE:HD11	1:A:61:LEU:HD13	2.00	0.42
1:A:224:LYS:HA	1:A:225:PRO:HD3	1.78	0.42
1:A:90:ALA:HB1	1:A:198:ILE:HD13	2.01	0.42
1:B:9:ILE:HD11	1:B:61:LEU:HD13	2.02	0.41
1:B:10:HIS:CE1	1:B:38:MET:H	2.15	0.41
1:A:11:THR:HB	1:A:80:ALA:HB3	2.03	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	260/262 (99%)	249 (96%)	11 (4%)	0	100	100
1	B	256/262 (98%)	245 (96%)	11 (4%)	0	100	100
All	All	516/524 (98%)	494 (96%)	22 (4%)	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	226/226 (100%)	213 (94%)	13 (6%)	18	16
1	B	222/226 (98%)	209 (94%)	13 (6%)	18	16
All	All	448/452 (99%)	422 (94%)	26 (6%)	18	16

All (26) residues with a non-rotameric sidechain are listed below:

Mol	Chain	Res	Type
1	A	18	ILE
1	A	21	LYS
1	A	62	LEU
1	A	72	GLU
1	A	106	LEU
1	A	129	ARG
1	A	135	THR
1	A	138	ASN
1	A	154	LEU
1	A	155	ARG
1	A	169	LEU
1	A	182	ASN
1	A	198	ILE
1	B	3	THR
1	B	18	ILE
1	B	32	LYS
1	B	68	LEU
1	B	103	HIS
1	B	106	LEU
1	B	154	LEU
1	B	155	ARG
1	B	163	THR
1	B	169	LEU
1	B	182	ASN
1	B	198	ILE
1	B	224	LYS

Sometimes sidechains can be flipped to improve hydrogen bonding and reduce clashes. All (18) such sidechains are listed below:

Mol	Chain	Res	Type
1	A	10	HIS
1	A	20	HIS
1	A	47	GLN
1	A	52	ASN

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Mol	Chain	Res	Type
1	A	85	ASN
1	A	138	ASN
1	A	181	GLN
1	A	182	ASN
1	A	216	GLN
1	A	251	GLN
1	B	10	HIS
1	B	20	HIS
1	B	47	GLN
1	B	52	ASN
1	B	85	ASN
1	B	181	GLN
1	B	182	ASN
1	B	216	GLN

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 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](#)

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	262/262 (100%)	-0.76	3 (1%) 78 80	11, 20, 37, 56	0
1	B	258/262 (98%)	-0.87	1 (0%) 88 90	12, 19, 32, 59	0
All	All	520/524 (99%)	-0.81	4 (0%) 82 84	11, 19, 35, 59	0

All (4) RSRZ outliers are listed below:

Mol	Chain	Res	Type	RSRZ
1	B	258	ALA	4.8
1	A	-4	PRO	3.2
1	A	214	ASP	2.6
1	A	248	HIS	2.5

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](#)

There are no ligands in this entry.

6.5 Other polymers [i](#)

There are no such residues in this entry.