



Full wwPDB X-ray Structure Validation Report ⓘ

Feb 4, 2024 – 09:14 PM EST

PDB ID : 8TLN
Title : STRUCTURAL COMPARISON SUGGESTS THAT THERMOLYSIN AND RELATED NEUTRAL PROTEASES UNDERGO HINGE-BENDING MOTION DURING CATALYSIS
Authors : Tronrud, D.; Matthews, B.W.
Deposited on : 1993-09-01
Resolution : 1.60 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 : 4.02b-467
Mogul : 1.8.5 (274361), CSD as541be (2020)
Xtriage (Phenix) : 1.13
EDS : 2.36
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

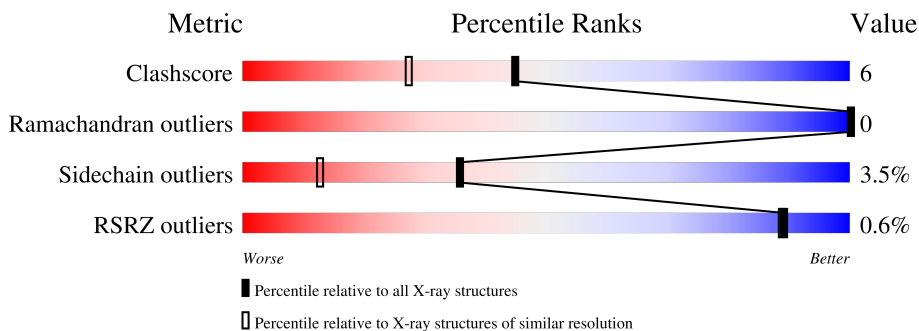
1 Overall quality at a glance

The following experimental techniques were used to determine the structure:

X-RAY DIFFRACTION

The reported resolution of this entry is 1.60 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	141614	3665 (1.60-1.60)
Ramachandran outliers	138981	3564 (1.60-1.60)
Sidechain outliers	138945	3563 (1.60-1.60)
RSRZ outliers	127900	3321 (1.60-1.60)

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	E	316	 % 75% 22% .

2 Entry composition [i](#)

There are 7 unique types of molecules in this entry. The entry contains 2621 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 THERMOLYSIN.

Mol	Chain	Residues	Atoms					ZeroOcc	AltConf	Trace
			Total	C	N	O	S			
1	E	316	2438	1530	411	495	2	0	2	0

- Molecule 2 is VALINE (three-letter code: VAL) (formula: C₅H₁₁NO₂).



Mol	Chain	Residues	Atoms				ZeroOcc	AltConf
			Total	C	N	O		
2	E	1	7	5	1	1	0	0

- Molecule 3 is LYSINE (three-letter code: LYS) (formula: C₆H₁₅N₂O₂).



Mol	Chain	Residues	Atoms				ZeroOcc	AltConf
			Total	C	N	O		
3	E	1	10	6	2	2	0	0

- Molecule 4 is CALCIUM ION (three-letter code: CA) (formula: Ca).

Mol	Chain	Residues	Atoms		ZeroOcc	AltConf
			Total	Ca		
4	E	4	4	4	0	0

- Molecule 5 is ZINC ION (three-letter code: ZN) (formula: Zn).

Mol	Chain	Residues	Atoms		ZeroOcc	AltConf
			Total	Zn		
5	E	1	1	1	0	0

- Molecule 6 is DIMETHYL SULFOXIDE (three-letter code: DMS) (formula: C₂H₆OS).



Mol	Chain	Residues	Atoms				ZeroOcc	AltConf
			Total	C	O	S		
6	E	1	4	2	1	1	0	0

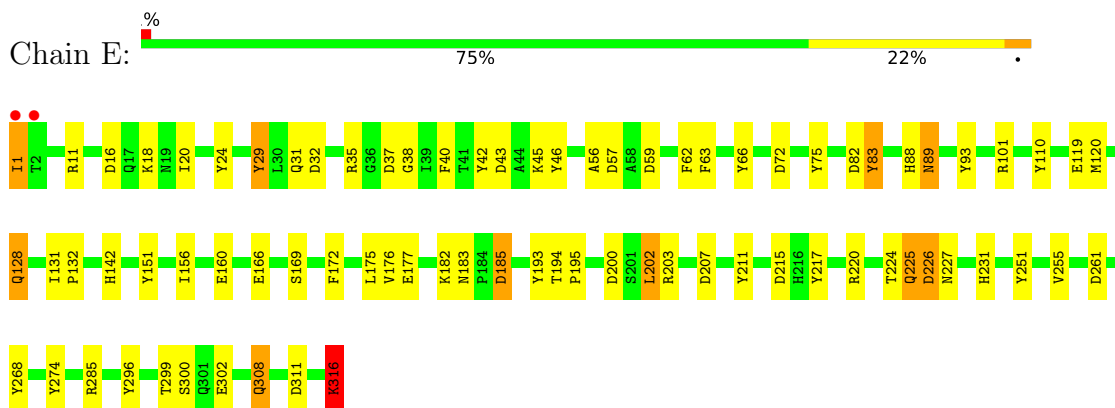
- Molecule 7 is water.

Mol	Chain	Residues	Atoms		ZeroOcc	AltConf
			Total	O		
7	E	157	157	157	0	0

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: THERMOLYSIN



4 Data and refinement statistics

Property	Value	Source
Space group	P 61 2 2	Depositor
Cell constants a, b, c, α , β , γ	94.10Å 94.10Å 131.40Å 90.00° 90.00° 120.00°	Depositor
Resolution (Å)	20.00 – 1.60 19.46 – 1.60	Depositor EDS
% Data completeness (in resolution range)	(Not available) (20.00-1.60) 76.2 (19.46-1.60)	Depositor EDS
R_{merge}	(Not available)	Depositor
R_{sym}	(Not available)	Depositor
$\langle I/\sigma(I) \rangle$ ¹	1.54 (at 1.60Å)	Xtrriage
Refinement program	TNT	Depositor
R, R_{free}	0.165 , (Not available) 0.177 , (Not available)	Depositor DCC
R_{free} test set	No test flags present.	wwPDB-VP
Wilson B-factor (Å ²)	12.4	Xtrriage
Anisotropy	0.167	Xtrriage
Bulk solvent k_{sol} (e/Å ³), B_{sol} (Å ²)	0.30 , 69.1	EDS
L-test for twinning ²	$\langle L \rangle = 0.50$, $\langle L^2 \rangle = 0.33$	Xtrriage
Estimated twinning fraction	No twinning to report.	Xtrriage
F_o, F_c correlation	0.96	EDS
Total number of atoms	2621	wwPDB-VP
Average B, all atoms (Å ²)	22.0	wwPDB-VP

Xtrriage's analysis on translational NCS is as follows: *The largest off-origin peak in the Patterson function is 3.52% 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: DMS, CA, ZN

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	E	1.31	6/2508 (0.2%)	1.81	67/3413 (2.0%)

All (6) bond length outliers are listed below:

Mol	Chain	Res	Type	Atoms	Z	Observed(Å)	Ideal(Å)
1	E	177	GLU	CD-OE2	7.77	1.34	1.25
1	E	160	GLU	CD-OE2	6.41	1.32	1.25
1	E	166	GLU	CD-OE2	-5.79	1.19	1.25
1	E	166	GLU	CD-OE1	5.60	1.31	1.25
1	E	110	TYR	CB-CG	-5.19	1.43	1.51
1	E	119	GLU	CD-OE1	5.10	1.31	1.25

All (67) bond angle outliers are listed below:

Mol	Chain	Res	Type	Atoms	Z	Observed(°)	Ideal(°)
1	E	200	ASP	CB-CG-OD2	-13.68	105.99	118.30
1	E	220	ARG	NE-CZ-NH1	9.97	125.28	120.30
1	E	93	TYR	CB-CG-CD2	-9.55	115.27	121.00
1	E	16	ASP	CB-CG-OD2	-9.17	110.05	118.30
1	E	215	ASP	CB-CG-OD2	-9.16	110.06	118.30
1	E	75	TYR	CB-CG-CD2	-8.66	115.80	121.00
1	E	29	TYR	CG-CD2-CE2	-8.47	114.52	121.30
1	E	29	TYR	CB-CG-CD1	-8.19	116.08	121.00
1	E	200	ASP	CB-CG-OD1	8.01	125.51	118.30
1	E	274	TYR	CB-CG-CD2	7.99	125.79	121.00
1	E	220	ARG	NE-CZ-NH2	-7.99	116.31	120.30
1	E	183	ASN	CB-CA-C	-7.72	94.97	110.40
1	E	203	ARG	NE-CZ-NH1	7.66	124.13	120.30
1	E	72	ASP	CB-CG-OD2	7.53	125.08	118.30
1	E	62	PHE	CB-CG-CD1	7.38	125.97	120.80

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Mol	Chain	Res	Type	Atoms	Z	Observed(°)	Ideal(°)
1	E	16	ASP	CB-CG-OD1	7.30	124.87	118.30
1	E	207	ASP	CB-CG-OD1	7.20	124.78	118.30
1	E	185	ASP	CB-CG-OD1	-7.11	111.90	118.30
1	E	24	TYR	CG-CD1-CE1	6.94	126.86	121.30
1	E	215	ASP	CB-CG-OD1	6.90	124.51	118.30
1	E	24	TYR	CD1-CE1-CZ	-6.83	113.66	119.80
1	E	110	TYR	CB-CG-CD2	-6.79	116.92	121.00
1	E	193	TYR	CB-CG-CD1	-6.79	116.93	121.00
1	E	217	TYR	CD1-CE1-CZ	-6.69	113.78	119.80
1	E	42	TYR	CB-CG-CD2	-6.68	116.99	121.00
1	E	226	ASP	CB-CG-OD1	6.57	124.22	118.30
1	E	207	ASP	CB-CG-OD2	-6.47	112.48	118.30
1	E	299	THR	CA-CB-CG2	-6.45	103.37	112.40
1	E	59	ASP	CB-CG-OD1	6.43	124.09	118.30
1	E	120	MET	CA-CB-CG	-6.28	102.62	113.30
1	E	285	ARG	NE-CZ-NH1	6.07	123.34	120.30
1	E	211	TYR	CG-CD2-CE2	6.06	126.15	121.30
1	E	29	TYR	CD1-CE1-CZ	-6.04	114.37	119.80
1	E	101	ARG	NE-CZ-NH2	6.03	123.31	120.30
1	E	57	ASP	CB-CG-OD1	6.00	123.70	118.30
1	E	202	LEU	CB-CG-CD1	-6.00	100.81	111.00
1	E	93	TYR	CZ-CE2-CD2	-5.99	114.41	119.80
1	E	151	TYR	CA-CB-CG	-5.93	102.14	113.40
1	E	231	HIS	N-CA-CB	5.91	121.25	110.60
1	E	83	TYR	CB-CG-CD1	-5.89	117.47	121.00
1	E	296	TYR	CB-CG-CD1	-5.89	117.47	121.00
1	E	93	TYR	CG-CD1-CE1	-5.87	116.60	121.30
1	E	225	GLN	CA-CB-CG	5.79	126.14	113.40
1	E	72	ASP	CB-CG-OD1	-5.72	113.16	118.30
1	E	316	LYS	CB-CG-CD	5.67	126.36	111.60
1	E	29	TYR	CZ-CE2-CD2	5.66	124.89	119.80
1	E	251	TYR	CZ-CE2-CD2	5.61	124.84	119.80
1	E	268	TYR	CB-CG-CD1	-5.60	117.64	121.00
1	E	251	TYR	N-CA-CB	5.59	120.67	110.60
1	E	83	TYR	CB-CG-CD2	5.55	124.33	121.00
1	E	43	ASP	CB-CG-OD2	-5.53	113.32	118.30
1	E	66	TYR	CB-CG-CD2	5.49	124.29	121.00
1	E	46	TYR	CZ-CE2-CD2	-5.37	114.96	119.80
1	E	172	PHE	CB-CG-CD1	-5.33	117.07	120.80
1	E	172	PHE	C-N-CA	-5.32	111.13	122.30
1	E	63	PHE	CG-CD2-CE2	5.30	126.63	120.80
1	E	1	ILE	O-C-N	-5.26	114.28	122.70

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Mol	Chain	Res	Type	Atoms	Z	Observed(°)	Ideal(°)
1	E	128	GLN	CB-CA-C	-5.23	99.95	110.40
1	E	37	ASP	CB-CG-OD2	5.21	122.99	118.30
1	E	211	TYR	CD1-CE1-CZ	5.18	124.46	119.80
1	E	82	ASP	CB-CG-OD2	-5.17	113.65	118.30
1	E	308	GLN	CB-CA-C	-5.16	100.08	110.40
1	E	24	TYR	CG-CD2-CE2	-5.12	117.20	121.30
1	E	274	TYR	CD1-CG-CD2	-5.11	112.28	117.90
1	E	296	TYR	CG-CD2-CE2	-5.07	117.24	121.30
1	E	63	PHE	CB-CG-CD1	5.06	124.34	120.80
1	E	261	ASP	CB-CG-OD2	5.04	122.83	118.30

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	E	2438	0	2273	31	0
2	E	7	0	8	0	0
3	E	10	0	13	1	0
4	E	4	0	0	0	0
5	E	1	0	0	0	0
6	E	4	0	6	0	0
7	E	157	0	0	0	0
All	All	2621	0	2300	31	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 (31) 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:E:1:ILE:CD1	1:E:29:TYR:CE2	2.58	0.86
1:E:1:ILE:CD1	1:E:29:TYR:CD2	2.67	0.77
1:E:311:ASP:OD1	1:E:316:LYS:HE3	1.84	0.76

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Atom-1	Atom-2	Interatomic distance (Å)	Clash overlap (Å)
1:E:1:ILE:HD11	1:E:29:TYR:CE2	2.24	0.72
1:E:1:ILE:HD11	1:E:29:TYR:CZ	2.26	0.70
1:E:1:ILE:HD12	1:E:29:TYR:CD2	2.32	0.64
1:E:1:ILE:HD12	1:E:29:TYR:CG	2.41	0.55
1:E:31:GLN:HG3	1:E:40:PHE:CE2	2.45	0.52
1:E:1:ILE:HD13	1:E:29:TYR:CE2	2.42	0.51
1:E:128:GLN:O	1:E:195:PRO:HD2	2.12	0.48
1:E:1:ILE:HD13	1:E:29:TYR:CD2	2.47	0.47
1:E:194:THR:HA	1:E:195:PRO:HD2	1.39	0.46
1:E:88:HIS:O	1:E:89:ASN:CB	2.64	0.45
1:E:11[A]:ARG:NH1	1:E:11[A]:ARG:HG3	2.31	0.45
1:E:131:ILE:HB	1:E:132:PRO:CD	2.48	0.44
1:E:1:ILE:HD13	1:E:1:ILE:HG21	1.71	0.44
1:E:255:VAL:HG22	1:E:308:GLN:HB3	1.99	0.44
1:E:194:THR:N	1:E:195:PRO:CD	2.76	0.43
1:E:175:LEU:HA	1:E:175:LEU:HD23	1.71	0.43
1:E:226:ASP:O	1:E:227:ASN:HB2	2.19	0.43
1:E:83:TYR:CG	1:E:176:VAL:HG22	2.54	0.42
1:E:29:TYR:CE1	1:E:56:ALA:HB2	2.54	0.42
1:E:142:HIS:CG	1:E:169:SER:HB3	2.54	0.42
1:E:131:ILE:O	1:E:132:PRO:C	2.56	0.42
1:E:32:ASP:O	1:E:38:GLY:HA2	2.20	0.41
1:E:202:LEU:HD21	3:E:1323:LYS:HB3	2.02	0.41
1:E:35:ARG:HH11	1:E:35:ARG:HD2	1.72	0.41
1:E:1:ILE:HB	1:E:31:GLN:HE22	1.86	0.41
1:E:194:THR:N	1:E:195:PRO:HD3	2.36	0.40
1:E:224:THR:O	1:E:225:GLN:C	2.59	0.40
1:E:300:SER:HB2	1:E:302:GLU:OE1	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	
1	E	316/316 (100%)	304 (96%)	12 (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	E	254/252 (101%)	246 (97%)	8 (3%)	40	15

All (8) residues with a non-rotameric sidechain are listed below:

Mol	Chain	Res	Type
1	E	18	LYS
1	E	20	ILE
1	E	45	LYS
1	E	89	ASN
1	E	156	ILE
1	E	182	LYS
1	E	185	ASP
1	E	316	LYS

Sometimes sidechains can be flipped to improve hydrogen bonding and reduce clashes. All (5) such sidechains are listed below:

Mol	Chain	Res	Type
1	E	31	GLN
1	E	33	ASN
1	E	97	ASN
1	E	290	GLN
1	E	308	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 monosaccharides in this entry.

5.6 Ligand geometry [i](#)

Of 8 ligands modelled in this entry, 5 are monoatomic - leaving 3 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	$\# Z > 2$
2	VAL	E	1322	3	4,6,7	1.01	0	6,7,9	1.44	1 (16%)
3	LYS	E	1323	2	8,9,9	1.19	1 (12%)	9,10,10	1.30	2 (22%)
6	DMS	E	324	-	3,3,3	0.35	0	3,3,3	0.82	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	VAL	E	1322	3	-	1/5/6/8	-
3	LYS	E	1323	2	-	1/9/9/9	-

All (1) bond length outliers are listed below:

Mol	Chain	Res	Type	Atoms	Z	Observed(Å)	Ideal(Å)
3	E	1323	LYS	O-C	2.91	1.31	1.22

All (3) bond angle outliers are listed below:

Mol	Chain	Res	Type	Atoms	Z	Observed(°)	Ideal(°)
3	E	1323	LYS	O-C-CA	-2.31	113.99	122.14
2	E	1322	VAL	CB-CA-C	-2.29	109.84	112.94
3	E	1323	LYS	CD-CG-CB	-2.06	106.34	113.62

There are no chirality outliers.

All (2) torsion outliers are listed below:

Mol	Chain	Res	Type	Atoms
2	E	1322	VAL	O-C-CA-CB
3	E	1323	LYS	CE-CD-CG-CB

There are no ring outliers.

1 monomer is involved in 1 short contact:

Mol	Chain	Res	Type	Clashes	Symm-Clashes
3	E	1323	LYS	1	0

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	E	316/316 (100%)	-0.59	2 (0%) 89 89	10, 18, 41, 62	0

All (2) RSRZ outliers are listed below:

Mol	Chain	Res	Type	RSRZ
1	E	2	THR	3.5
1	E	1	ILE	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 monosaccharides 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(Å ²)	Q<0.9
3	LYS	E	1323	10/10	0.89	0.15	24,35,74,100	0
2	VAL	E	1322	7/8	0.90	0.09	18,24,31,68	0
6	DMS	E	324	4/4	0.96	0.10	40,56,57,62	0
4	CA	E	319	1/1	0.99	0.03	15,15,15,15	0
4	CA	E	320	1/1	0.99	0.04	20,20,20,20	0

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Mol	Type	Chain	Res	Atoms	RSCC	RSR	B-factors(\AA^2)	Q<0.9
5	ZN	E	321	1/1	0.99	0.02	16,16,16,16	0
4	CA	E	318	1/1	0.99	0.02	16,16,16,16	0
4	CA	E	317	1/1	1.00	0.02	14,14,14,14	0

6.5 Other polymers [i](#)

There are no such residues in this entry.