



Full wwPDB X-ray Structure Validation Report ⓘ

Mar 1, 2026 – 04:35 PM UTC

PDB ID : 3H4R / pdb_00003h4r
Title : Crystal structure of E. coli RecE exonuclease
Authors : Bell, C.E.; Zhang, J.
Deposited on : 2009-04-20
Resolution : 2.80 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

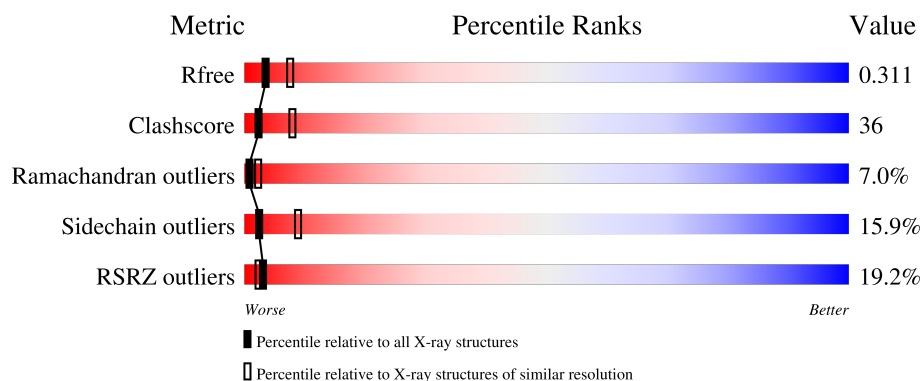
1 Overall quality at a glance

The following experimental techniques were used to determine the structure:

X-RAY DIFFRACTION

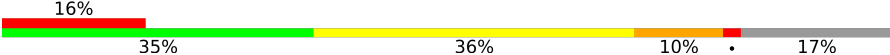
The reported resolution of this entry is 2.80 Å.

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	3866 (2.80-2.80)
Clashscore	190562	4276 (2.80-2.80)
Ramachandran outliers	187476	4196 (2.80-2.80)
Sidechain outliers	187428	4198 (2.80-2.80)
RSRZ outliers	180081	3869 (2.80-2.80)

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	265	

2 Entry composition

There is only 1 type of molecule in this entry. The entry contains 1736 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 Exodeoxyribonuclease 8.

Mol	Chain	Residues	Atoms					ZeroOcc	AltConf	Trace
			Total	C	N	O	S			
1	A	219	1736	1112	289	325	10	0	0	0

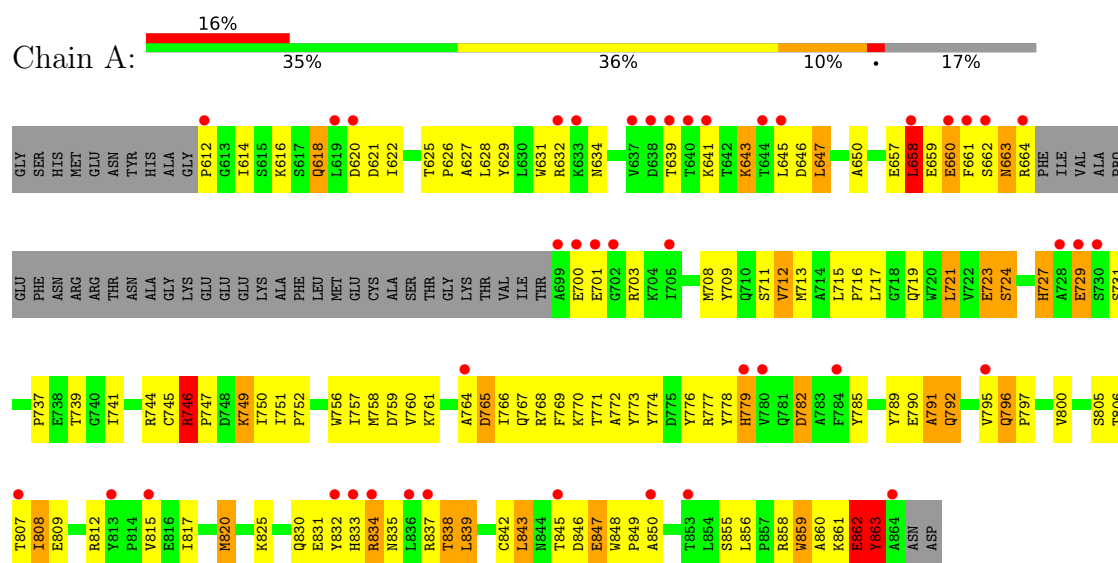
There are 5 discrepancies between the modelled and reference sequences:

Chain	Residue	Modelled	Actual	Comment	Reference
A	-3	GLY	-	expression tag	UNP P15032
A	-2	SER	-	expression tag	UNP P15032
A	-1	HIS	-	expression tag	UNP P15032
A	0	MET	-	expression tag	UNP P15032
A	658	LEU	PRO	engineered mutation	UNP P15032

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: Exodeoxyribonuclease 8



4 Data and refinement statistics

Property	Value	Source
Space group	P 4 21 2	Depositor
Cell constants a, b, c, α , β , γ	123.20Å 123.20Å 67.26Å 90.00° 90.00° 90.00°	Depositor
Resolution (Å)	45.43 – 2.80 45.43 – 2.80	Depositor EDS
% Data completeness (in resolution range)	99.4 (45.43-2.80) 99.4 (45.43-2.80)	Depositor EDS
R_{merge}	0.08	Depositor
R_{sym}	(Not available)	Depositor
$\langle I/\sigma(I) \rangle$ ¹	3.15 (at 2.39Å)	Xtriage
Refinement program	CNS 1.2	Depositor
R, R_{free}	0.290 , 0.313 0.290 , 0.311	Depositor DCC
R_{free} test set	656 reflections (3.19%)	wwPDB-VP
Wilson B-factor (Å ²)	41.4	Xtriage
Anisotropy	0.335	Xtriage
Bulk solvent k_{sol} (e/Å ³), B_{sol} (Å ²)	0.36 , 76.5	EDS
L-test for twinning ²	$\langle L \rangle = 0.47$, $\langle L^2 \rangle = 0.30$	Xtriage
Estimated twinning fraction	No twinning to report.	Xtriage
F_o, F_c correlation	0.92	EDS
Total number of atoms	1736	wwPDB-VP
Average B, all atoms (Å ²)	97.0	wwPDB-VP

Xtriage's analysis on translational NCS is as follows: *The largest off-origin peak in the Patterson function is 5.94% 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](#)

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	0.54	0/1783	1.03	10/2425 (0.4%)

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

There are no bond length outliers.

All (10) bond angle outliers are listed below:

Mol	Chain	Res	Type	Atoms	Z	Observed($^{\circ}$)	Ideal($^{\circ}$)
1	A	776	TYR	N-CA-C	-6.99	104.79	113.38
1	A	751	ILE	CA-C-N	6.72	128.24	119.84
1	A	751	ILE	C-N-CA	6.72	128.24	119.84
1	A	782	ASP	N-CA-C	-6.03	103.46	111.24
1	A	631	TRP	N-CA-C	-5.89	104.49	111.03
1	A	834	ARG	N-CA-C	-5.69	104.98	111.07
1	A	746	ARG	CA-C-N	5.66	126.92	119.84
1	A	746	ARG	C-N-CA	5.66	126.92	119.84
1	A	700	GLU	N-CA-C	-5.47	106.81	112.93
1	A	658	LEU	N-CA-C	5.15	116.89	111.28

There are no chirality outliers.

All (1) planarity outliers are listed below:

Mol	Chain	Res	Type	Group
1	A	863	TYR	Sidechain

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	1736	0	1624	120	0
All	All	1736	0	1624	120	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 36.

All (120) 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:777:ARG:NH2	1:A:835:ASN:HD21	1.68	0.91
1:A:777:ARG:HH22	1:A:835:ASN:ND2	1.71	0.87
1:A:777:ARG:HH22	1:A:835:ASN:HD21	0.87	0.87
1:A:765:ASP:HB2	1:A:768:ARG:HB3	1.56	0.86
1:A:620:ASP:OD1	1:A:777:ARG:HD3	1.75	0.85
1:A:834:ARG:O	1:A:838:THR:HG22	1.77	0.83
1:A:713:MET:HE3	1:A:719:GLN:HG3	1.60	0.83
1:A:800:VAL:HG13	1:A:817:ILE:HG23	1.65	0.78
1:A:859:TRP:H	1:A:859:TRP:CD1	2.01	0.76
1:A:663:ASN:HD22	1:A:663:ASN:N	1.82	0.75
1:A:750:ILE:HD11	1:A:789:TYR:CE2	2.26	0.71
1:A:750:ILE:O	1:A:752:PRO:HD3	1.91	0.71
1:A:712:VAL:HG12	1:A:815:VAL:HG21	1.74	0.70
1:A:800:VAL:CG1	1:A:817:ILE:HG23	2.22	0.69
1:A:765:ASP:HB2	1:A:768:ARG:CB	2.23	0.68
1:A:845:THR:O	1:A:847:GLU:N	2.27	0.68
1:A:750:ILE:HD11	1:A:789:TYR:HE2	1.58	0.67
1:A:741:ILE:HD13	1:A:839:LEU:HD12	1.75	0.67
1:A:658:LEU:HD12	1:A:658:LEU:H	1.63	0.64
1:A:647:LEU:HD13	1:A:806:THR:HG21	1.80	0.64
1:A:779:HIS:H	1:A:779:HIS:CD2	2.14	0.63
1:A:769:PHE:O	1:A:771:THR:N	2.32	0.63
1:A:663:ASN:N	1:A:663:ASN:ND2	2.48	0.62
1:A:749:LYS:HD3	1:A:750:ILE:N	2.17	0.60
1:A:835:ASN:O	1:A:838:THR:HG23	2.02	0.59
1:A:709:TYR:O	1:A:713:MET:HG2	2.02	0.58

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Atom-1	Atom-2	Interatomic distance (Å)	Clash overlap (Å)
1:A:761:LYS:HE2	1:A:778:TYR:CZ	2.38	0.58
1:A:758:MET:HE3	1:A:760:VAL:HG23	1.86	0.57
1:A:777:ARG:NH2	1:A:831:GLU:HG3	2.19	0.57
1:A:645:LEU:C	1:A:647:LEU:H	2.12	0.57
1:A:808:ILE:HG13	1:A:812:ARG:O	2.04	0.57
1:A:858:ARG:HG3	1:A:859:TRP:HD1	1.68	0.57
1:A:622:ILE:HD11	1:A:629:TYR:CD2	2.40	0.57
1:A:708:MET:HE3	1:A:805:SER:O	2.05	0.56
1:A:779:HIS:H	1:A:779:HIS:HD2	1.54	0.56
1:A:625:THR:HG21	1:A:850:ALA:HA	1.87	0.56
1:A:713:MET:CE	1:A:719:GLN:HG3	2.34	0.56
1:A:727:HIS:N	1:A:727:HIS:CD2	2.73	0.56
1:A:621:ASP:OD2	1:A:632:ARG:HD2	2.05	0.55
1:A:861:LYS:C	1:A:863:TYR:H	2.14	0.54
1:A:772:ALA:O	1:A:773:TYR:C	2.50	0.54
1:A:750:ILE:O	1:A:750:ILE:HG23	2.08	0.53
1:A:773:TYR:CG	1:A:774:TYR:N	2.76	0.53
1:A:761:LYS:HE2	1:A:778:TYR:CE1	2.44	0.52
1:A:858:ARG:HG3	1:A:859:TRP:N	2.24	0.52
1:A:839:LEU:O	1:A:843:LEU:HD22	2.09	0.52
1:A:858:ARG:HG3	1:A:859:TRP:CD1	2.46	0.51
1:A:842:CYS:HB3	1:A:848:TRP:CD2	2.45	0.51
1:A:806:THR:O	1:A:807:THR:HG23	2.10	0.51
1:A:765:ASP:OD2	1:A:765:ASP:N	2.43	0.51
1:A:779:HIS:HA	1:A:820:MET:HE3	1.92	0.50
1:A:612:PRO:HB2	1:A:744:ARG:NH2	2.27	0.50
1:A:620:ASP:HA	1:A:777:ARG:NH1	2.27	0.50
1:A:833:HIS:HB3	1:A:837:ARG:NH2	2.25	0.50
1:A:709:TYR:C	1:A:709:TYR:CD1	2.91	0.49
1:A:791:ALA:O	1:A:792:GLN:HB2	2.11	0.49
1:A:712:VAL:HG12	1:A:815:VAL:CG2	2.41	0.49
1:A:731:SER:HA	1:A:746:ARG:HB3	1.94	0.49
1:A:769:PHE:C	1:A:771:THR:H	2.21	0.49
1:A:833:HIS:HB3	1:A:837:ARG:HH21	1.78	0.49
1:A:795:VAL:HG22	1:A:796:GLN:N	2.27	0.48
1:A:834:ARG:HA	1:A:837:ARG:NH1	2.29	0.48
1:A:721:LEU:HD11	1:A:756:TRP:CE3	2.49	0.48
1:A:660:GLU:O	1:A:660:GLU:OE1	2.33	0.47
1:A:779:HIS:CA	1:A:820:MET:HE3	2.45	0.47
1:A:858:ARG:HG3	1:A:859:TRP:H	1.79	0.47
1:A:790:GLU:O	1:A:792:GLN:N	2.43	0.46

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Atom-1	Atom-2	Interatomic distance (Å)	Clash overlap (Å)
1:A:625:THR:CG2	1:A:850:ALA:HA	2.46	0.46
1:A:612:PRO:HB2	1:A:744:ARG:HH21	1.80	0.46
1:A:627:ALA:C	1:A:629:TYR:N	2.74	0.46
1:A:782:ASP:OD1	1:A:825:LYS:HE2	2.16	0.45
1:A:759:ASP:OD1	1:A:761:LYS:HD3	2.15	0.45
1:A:701:GLU:C	1:A:703:ARG:H	2.23	0.45
1:A:708:MET:O	1:A:711:SER:N	2.43	0.45
1:A:717:LEU:HD12	1:A:817:ILE:HG12	1.98	0.45
1:A:663:ASN:O	1:A:664:ARG:C	2.60	0.45
1:A:620:ASP:HA	1:A:777:ARG:HH11	1.81	0.45
1:A:769:PHE:O	1:A:772:ALA:N	2.49	0.45
1:A:626:PRO:O	1:A:629:TYR:HB3	2.17	0.44
1:A:777:ARG:HH21	1:A:831:GLU:CG	2.31	0.44
1:A:773:TYR:CD2	1:A:774:TYR:N	2.86	0.44
1:A:860:ALA:C	1:A:862:GLU:N	2.75	0.44
1:A:764:ALA:C	1:A:765:ASP:OD2	2.61	0.43
1:A:627:ALA:C	1:A:629:TYR:H	2.26	0.43
1:A:643:LYS:C	1:A:645:LEU:H	2.26	0.43
1:A:645:LEU:C	1:A:647:LEU:N	2.76	0.43
1:A:647:LEU:O	1:A:650:ALA:HB3	2.19	0.43
1:A:790:GLU:HG3	1:A:795:VAL:HA	2.01	0.43
1:A:659:GLU:H	1:A:659:GLU:CD	2.27	0.43
1:A:662:SER:C	1:A:663:ASN:HD22	2.26	0.43
1:A:749:LYS:HD3	1:A:750:ILE:H	1.84	0.42
1:A:861:LYS:C	1:A:863:TYR:N	2.76	0.42
1:A:717:LEU:CD1	1:A:817:ILE:HG12	2.49	0.42
1:A:758:MET:HG2	1:A:759:ASP:N	2.34	0.42
1:A:741:ILE:HD13	1:A:839:LEU:CD1	2.46	0.42
1:A:614:ILE:HA	1:A:618:GLN:NE2	2.34	0.42
1:A:626:PRO:HG2	1:A:849:PRO:HG2	2.00	0.42
1:A:745:CYS:O	1:A:745:CYS:SG	2.77	0.42
1:A:661:PHE:C	1:A:663:ASN:N	2.78	0.42
1:A:701:GLU:C	1:A:703:ARG:N	2.75	0.42
1:A:745:CYS:HB2	1:A:785:TYR:CE2	2.54	0.42
1:A:746:ARG:HA	1:A:747:PRO:HD2	1.71	0.42
1:A:790:GLU:OE2	1:A:796:GLN:NE2	2.53	0.42
1:A:792:GLN:O	1:A:792:GLN:CD	2.63	0.41
1:A:766:ILE:HD13	1:A:766:ILE:HA	1.89	0.41
1:A:717:LEU:HD13	1:A:721:LEU:HD22	2.02	0.41
1:A:769:PHE:C	1:A:771:THR:N	2.77	0.41
1:A:616:LYS:NZ	1:A:620:ASP:OD2	2.44	0.41

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Atom-1	Atom-2	Interatomic distance (Å)	Clash overlap (Å)
1:A:832:TYR:HA	1:A:835:ASN:HD22	1.85	0.41
1:A:715:LEU:HA	1:A:716:PRO:HD2	1.89	0.41
1:A:777:ARG:HH21	1:A:831:GLU:HG3	1.86	0.41
1:A:645:LEU:O	1:A:647:LEU:N	2.52	0.41
1:A:830:GLN:O	1:A:834:ARG:HB2	2.20	0.41
1:A:831:GLU:HA	1:A:834:ARG:NH2	2.36	0.41
1:A:855:SER:O	1:A:856:LEU:C	2.64	0.41
1:A:723:GLU:HB3	1:A:724:SER:H	1.66	0.40
1:A:739:THR:HB	1:A:741:ILE:HG13	2.02	0.40
1:A:739:THR:CB	1:A:741:ILE:HG13	2.52	0.40
1:A:643:LYS:C	1:A:645:LEU:N	2.79	0.40
1:A:807:THR:O	1:A:808:ILE:C	2.64	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	215/265 (81%)	164 (76%)	36 (17%)	15 (7%)	1 2

All (15) Ramachandran outliers are listed below:

Mol	Chain	Res	Type
1	A	639	THR
1	A	641	LYS
1	A	643	LYS
1	A	770	LYS
1	A	792	GLN
1	A	846	ASP
1	A	634	ASN
1	A	724	SER
1	A	862	GLU

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Mol	Chain	Res	Type
1	A	863	TYR
1	A	791	ALA
1	A	646	ASP
1	A	723	GLU
1	A	729	GLU
1	A	808	ILE

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	176/227 (78%)	148 (84%)	28 (16%)	2 9

All (28) residues with a non-rotameric sidechain are listed below:

Mol	Chain	Res	Type
1	A	618	GLN
1	A	628	LEU
1	A	647	LEU
1	A	657	GLU
1	A	658	LEU
1	A	660	GLU
1	A	663	ASN
1	A	712	VAL
1	A	721	LEU
1	A	727	HIS
1	A	729	GLU
1	A	737	PRO
1	A	746	ARG
1	A	749	LYS
1	A	757	ILE
1	A	765	ASP
1	A	767	GLN
1	A	779	HIS
1	A	796	GLN
1	A	797	PRO

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Mol	Chain	Res	Type
1	A	809	GLU
1	A	820	MET
1	A	838	THR
1	A	839	LEU
1	A	843	LEU
1	A	847	GLU
1	A	859	TRP
1	A	862	GLU

Sometimes sidechains can be flipped to improve hydrogen bonding and reduce clashes. All (7) such sidechains are listed below:

Mol	Chain	Res	Type
1	A	618	GLN
1	A	663	ASN
1	A	727	HIS
1	A	779	HIS
1	A	796	GLN
1	A	830	GLN
1	A	835	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 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 ⓘ

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, 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	219/265 (82%)	1.32	42 (19%) 3 2	56, 95, 133, 146	0

All (42) RSRZ outliers are listed below:

Mol	Chain	Res	Type	RSRZ
1	A	700	GLU	6.5
1	A	638	ASP	5.8
1	A	699	ALA	5.3
1	A	834	ARG	4.2
1	A	864	ALA	4.2
1	A	664	ARG	4.1
1	A	701	GLU	4.0
1	A	658	LEU	4.0
1	A	639	THR	4.0
1	A	832	TYR	4.0
1	A	640	THR	3.4
1	A	833	HIS	3.2
1	A	619	LEU	3.2
1	A	612	PRO	3.2
1	A	661	PHE	3.1
1	A	644	THR	3.1
1	A	637	VAL	2.9
1	A	633	LYS	2.9
1	A	836	LEU	2.9
1	A	780	VAL	2.8
1	A	850	ALA	2.8
1	A	813	TYR	2.8
1	A	784	PHE	2.7
1	A	632	ARG	2.7
1	A	815	VAL	2.7
1	A	660	GLU	2.6
1	A	620	ASP	2.6

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Mol	Chain	Res	Type	RSRZ
1	A	807	THR	2.5
1	A	779	HIS	2.5
1	A	641	LYS	2.5
1	A	729	GLU	2.4
1	A	853	THR	2.4
1	A	845	THR	2.4
1	A	702	GLY	2.4
1	A	730	SER	2.4
1	A	764	ALA	2.3
1	A	795	VAL	2.3
1	A	662	SER	2.2
1	A	837	ARG	2.2
1	A	645	LEU	2.2
1	A	705	ILE	2.1
1	A	728	ALA	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 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.