



Full wwPDB X-ray Structure Validation Report ⓘ

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PDB ID : 2JLN / pdb_00002jln
Title : Structure of Mhp1, a nucleobase-cation-symport-1 family transporter
Authors : Weyand, S.; Shimamura, T.; Yajima, S.; Suzuki, S.; Mirza, O.; Krusong, K.; Carpenter, E.P.; Rutherford, N.G.; Hadden, J.M.; O'Reilly, J.; Ma, P.; Saidijam, M.; Patching, S.G.; Hope, R.J.; Norbertczak, H.T.; Roach, P.C.J.; Iwata, S.; Henderson, P.J.F.; Cameron, A.D.
Deposited on : 2008-09-11
Resolution : 2.85 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

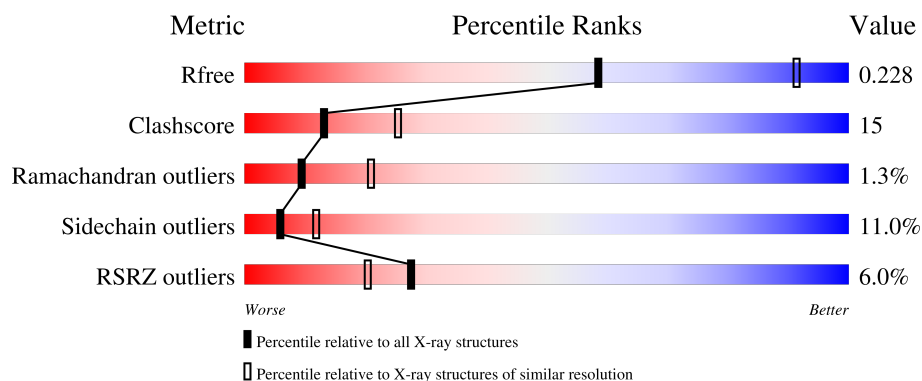
1 Overall quality at a glance

The following experimental techniques were used to determine the structure:

X-RAY DIFFRACTION

The reported resolution of this entry is 2.85 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	1407 (2.88-2.84)
Clashscore	190562	1446 (2.88-2.84)
Ramachandran outliers	187476	1406 (2.88-2.84)
Sidechain outliers	187428	1407 (2.88-2.84)
RSRZ outliers	180081	1408 (2.88-2.84)

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	501	 6% 60% 28% 5% 7%

2 Entry composition

There are 3 unique types of molecules in this entry. The entry contains 3571 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 MHP1.

Mol	Chain	Residues	Atoms					ZeroOcc	AltConf	Trace
1	A	464	Total	C	N	O	S	0	0	1
			3569	2369	577	601	22			

- Molecule 2 is SODIUM ION (CCD ID: NA) (formula: Na).

Mol	Chain	Residues	Atoms		ZeroOcc	AltConf
2	A	1	Total	Na	0	0
			1	1		

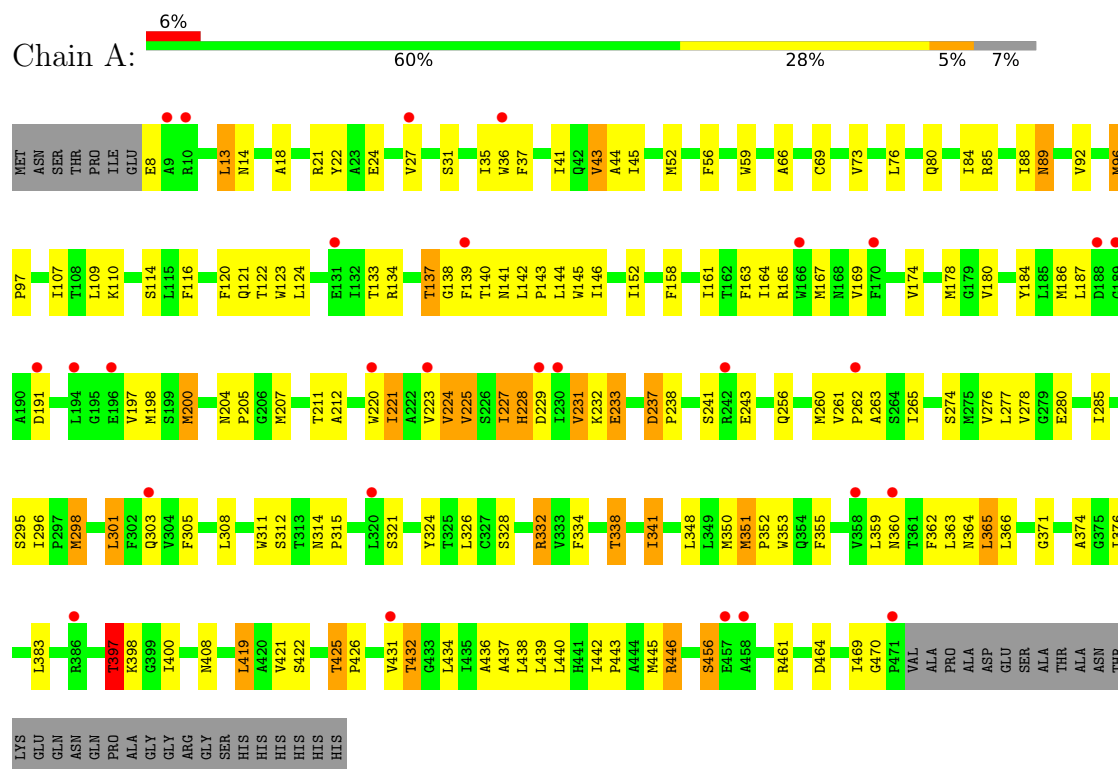
- Molecule 3 is MERCURY (II) ION (CCD ID: HG) (formula: Hg).

Mol	Chain	Residues	Atoms		ZeroOcc	AltConf
3	A	1	Total	Hg	0	0
			1	1		

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: MHP1



4 Data and refinement statistics

Property	Value	Source
Space group	P 21 21 21	Depositor
Cell constants a, b, c, α , β , γ	79.70Å 109.14Å 113.82Å 90.00° 90.00° 90.00°	Depositor
Resolution (Å)	29.01 – 2.85 29.01 – 2.85	Depositor EDS
% Data completeness (in resolution range)	88.0 (29.01-2.85) 93.6 (29.01-2.85)	Depositor EDS
R_{merge}	0.12	Depositor
R_{sym}	(Not available)	Depositor
$\langle I/\sigma(I) \rangle$ ¹	1.43 (at 2.85Å)	Xtriage
Refinement program	PHENIX (PHENIX.REFINE)	Depositor
R, R_{free}	0.234 , 0.281 0.224 , 0.228	Depositor DCC
R_{free} test set	1137 reflections (5.10%)	wwPDB-VP
Wilson B-factor (Å ²)	73.1	Xtriage
Anisotropy	0.198	Xtriage
Bulk solvent k_{sol} (e/Å ³), B_{sol} (Å ²)	0.27 , 25.3	EDS
L-test for twinning ²	$\langle L \rangle = 0.47$, $\langle L^2 \rangle = 0.30$	Xtriage
Estimated twinning fraction	0.027 for -h,l,k	Xtriage
F_o, F_c correlation	0.91	EDS
Total number of atoms	3571	wwPDB-VP
Average B, all atoms (Å ²)	60.0	wwPDB-VP

Xtriage's analysis on translational NCS is as follows: *The largest off-origin peak in the Patterson function is 4.65% 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: NA, HG

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	0.75	1/3667 (0.0%)	1.05	16/5013 (0.3%)

All (1) bond length outliers are listed below:

Mol	Chain	Res	Type	Atoms	Z	Observed(Å)	Ideal(Å)
1	A	470	GLY	C-N	-6.31	1.24	1.34

All (16) bond angle outliers are listed below:

Mol	Chain	Res	Type	Atoms	Z	Observed(°)	Ideal(°)
1	A	321	SER	CA-C-N	-8.42	109.31	119.84
1	A	321	SER	C-N-CA	-8.42	109.31	119.84
1	A	73	VAL	N-CA-C	8.30	118.39	110.42
1	A	397	THR	N-CA-C	6.90	119.68	111.33
1	A	425	THR	CA-C-N	6.69	128.21	119.84
1	A	425	THR	C-N-CA	6.69	128.21	119.84
1	A	351	MET	CA-C-N	6.04	126.15	119.87
1	A	351	MET	C-N-CA	6.04	126.15	119.87
1	A	89	ASN	CB-CA-C	-5.97	98.53	110.42
1	A	88	ILE	N-CA-C	5.88	118.23	109.17
1	A	200	MET	CA-C-N	-5.17	116.87	122.55
1	A	200	MET	C-N-CA	-5.17	116.87	122.55
1	A	439	LEU	N-CA-C	5.16	116.90	111.28
1	A	237	ASP	CA-C-N	5.10	124.89	119.28
1	A	237	ASP	C-N-CA	5.10	124.89	119.28
1	A	285	ILE	CB-CA-C	-5.08	105.46	111.97

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	3569	0	3663	108	0
2	A	1	0	0	0	0
3	A	1	0	0	0	0
All	All	3571	0	3663	108	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 15.

All (108) 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:13:LEU:HD12	1:A:14:ASN:N	1.84	0.93
1:A:324:TYR:O	1:A:328:SER:HB3	1.70	0.92
1:A:52:MET:HE1	1:A:212:ALA:HB1	1.54	0.89
1:A:220:TRP:CZ2	1:A:260:MET:HE3	2.12	0.84
1:A:408:ASN:HD21	1:A:445:MET:HE1	1.48	0.78
1:A:59:TRP:HB3	1:A:198:MET:HG3	1.69	0.73
1:A:225:VAL:HG22	1:A:374:ALA:HB2	1.71	0.72
1:A:52:MET:HE1	1:A:212:ALA:CB	2.21	0.71
1:A:400:ILE:HD13	1:A:456:SER:HB3	1.73	0.71
1:A:56:PHE:HE2	1:A:207:MET:HE2	1.57	0.69
1:A:52:MET:SD	1:A:207:MET:HE1	2.34	0.68
1:A:274:SER:HB3	1:A:280:GLU:O	1.94	0.67
1:A:397:THR:HG22	1:A:398:LYS:HG3	1.75	0.67
1:A:158:PHE:HZ	1:A:341:ILE:HD11	1.58	0.66
1:A:419:LEU:O	1:A:422:SER:HB3	1.95	0.65
1:A:256:GLN:O	1:A:260:MET:HG2	1.97	0.64
1:A:13:LEU:HD11	1:A:18:ALA:HB2	1.80	0.64
1:A:225:VAL:CG2	1:A:374:ALA:HB2	2.28	0.64
1:A:13:LEU:HD12	1:A:14:ASN:H	1.61	0.63
1:A:84:ILE:HG13	1:A:231:VAL:HG13	1.81	0.62
1:A:227:ILE:O	1:A:228:HIS:C	2.40	0.62
1:A:314:ASN:HB3	1:A:315:PRO:HD3	1.80	0.62
1:A:362:PHE:CE2	1:A:366:LEU:HD11	2.35	0.62
1:A:37:PHE:CD2	1:A:263:ALA:HB2	2.35	0.61

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Atom-1	Atom-2	Interatomic distance (Å)	Clash overlap (Å)
1:A:174:VAL:O	1:A:178:MET:HG3	2.00	0.61
1:A:442:ILE:HB	1:A:443:PRO:HD3	1.82	0.61
1:A:52:MET:CE	1:A:212:ALA:HB1	2.28	0.61
1:A:96:MET:HB3	1:A:97:PRO:HD3	1.82	0.60
1:A:96:MET:HB3	1:A:97:PRO:CD	2.32	0.60
1:A:165:ARG:O	1:A:169:VAL:HG23	2.02	0.60
1:A:352:PRO:HD2	1:A:353:TRP:CZ3	2.36	0.59
1:A:89:ASN:HB2	1:A:92:VAL:HB	1.84	0.59
1:A:376:ILE:HG13	1:A:437:ALA:HB1	1.83	0.59
1:A:76:LEU:O	1:A:80:GLN:HG2	2.04	0.58
1:A:197:VAL:HA	1:A:200:MET:HG3	1.86	0.58
1:A:359:LEU:O	1:A:360:ASN:C	2.47	0.57
1:A:85:ARG:O	1:A:85:ARG:HD3	2.05	0.57
1:A:116:PHE:CE1	1:A:363:LEU:HD11	2.39	0.57
1:A:69:CYS:SG	1:A:260:MET:HE2	2.45	0.56
1:A:461:ARG:O	1:A:464:ASP:HB2	2.05	0.56
1:A:37:PHE:CE1	1:A:41:ILE:HD11	2.41	0.56
1:A:133:THR:HG21	1:A:145:TRP:HZ2	1.70	0.55
1:A:134:ARG:HB3	1:A:139:PHE:O	2.07	0.54
1:A:56:PHE:CE2	1:A:207:MET:HE2	2.42	0.54
1:A:400:ILE:HG21	1:A:456:SER:HB3	1.89	0.54
1:A:334:PHE:HD2	1:A:338:THR:HG22	1.72	0.54
1:A:43:VAL:HG21	1:A:124:LEU:HD13	1.89	0.54
1:A:232:LYS:HE3	1:A:233:GLU:OE1	2.08	0.54
1:A:408:ASN:HD21	1:A:445:MET:CE	2.18	0.53
1:A:298:MET:HE3	1:A:301:LEU:HD12	1.90	0.52
1:A:163:PHE:O	1:A:164:ILE:C	2.52	0.52
1:A:84:ILE:CG1	1:A:231:VAL:HG13	2.39	0.52
1:A:8:GLU:HA	1:A:8:GLU:OE2	2.09	0.51
1:A:137:THR:C	1:A:139:PHE:H	2.19	0.51
1:A:186:MET:HE2	1:A:277:LEU:HD12	1.93	0.50
1:A:21:ARG:HB2	1:A:24:GLU:HG3	1.94	0.50
1:A:122:THR:HG21	1:A:348:LEU:HD21	1.92	0.50
1:A:227:ILE:O	1:A:229:ASP:N	2.44	0.49
1:A:85:ARG:HD3	1:A:85:ARG:C	2.37	0.49
1:A:158:PHE:HZ	1:A:341:ILE:CD1	2.23	0.49
1:A:351:MET:HA	1:A:353:TRP:CH2	2.47	0.49
1:A:36:TRP:CZ3	1:A:220:TRP:CZ3	3.01	0.49
1:A:355:PHE:HB3	1:A:359:LEU:CD1	2.42	0.49
1:A:120:PHE:O	1:A:123:TRP:HB3	2.12	0.49
1:A:350:MET:O	1:A:351:MET:C	2.55	0.49

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Atom-1	Atom-2	Interatomic distance (Å)	Clash overlap (Å)
1:A:22:TYR:CZ	1:A:238:PRO:HB3	2.48	0.49
1:A:220:TRP:O	1:A:221:ILE:C	2.56	0.48
1:A:278:VAL:O	1:A:278:VAL:CG1	2.62	0.48
1:A:43:VAL:O	1:A:44:ALA:C	2.56	0.48
1:A:220:TRP:CZ2	1:A:260:MET:CE	2.92	0.48
1:A:43:VAL:HG12	1:A:44:ALA:N	2.28	0.48
1:A:231:VAL:C	1:A:233:GLU:H	2.21	0.48
1:A:137:THR:O	1:A:137:THR:HG22	2.13	0.47
1:A:422:SER:HA	1:A:432:THR:HG22	1.96	0.47
1:A:13:LEU:O	1:A:332:ARG:NH2	2.39	0.47
1:A:400:ILE:HG21	1:A:456:SER:CB	2.44	0.47
1:A:178:MET:CE	1:A:305:PHE:HB2	2.45	0.47
1:A:133:THR:HG21	1:A:145:TRP:CZ2	2.49	0.46
1:A:152:ILE:CG2	1:A:311:TRP:CZ2	2.99	0.46
1:A:438:LEU:C	1:A:438:LEU:HD23	2.41	0.46
1:A:84:ILE:HG13	1:A:231:VAL:CG1	2.46	0.46
1:A:141:ASN:OD1	1:A:143:PRO:HD2	2.16	0.46
1:A:142:LEU:HB3	1:A:143:PRO:HD3	1.98	0.45
1:A:110:LYS:HD3	1:A:110:LYS:C	2.41	0.45
1:A:204:ASN:N	1:A:205:PRO:CD	2.79	0.45
1:A:383:LEU:HD13	1:A:442:ILE:HD11	1.98	0.45
1:A:355:PHE:HB3	1:A:359:LEU:HD12	2.00	0.44
1:A:27:VAL:HG22	1:A:165:ARG:HD2	1.98	0.44
1:A:425:THR:N	1:A:426:PRO:HD3	2.33	0.43
1:A:140:THR:HG22	1:A:140:THR:O	2.18	0.42
1:A:371:GLY:O	1:A:434:LEU:HA	2.19	0.42
1:A:326:LEU:C	1:A:328:SER:H	2.27	0.42
1:A:184:TYR:CD2	1:A:184:TYR:C	2.97	0.42
1:A:211:THR:O	1:A:211:THR:HG22	2.18	0.42
1:A:446:ARG:HD3	1:A:446:ARG:HA	1.89	0.42
1:A:31:SER:O	1:A:35:ILE:HG13	2.19	0.42
1:A:308:LEU:HD12	1:A:308:LEU:HA	1.83	0.42
1:A:436:ALA:O	1:A:440:LEU:HG	2.20	0.42
1:A:362:PHE:O	1:A:365:LEU:HB2	2.20	0.41
1:A:76:LEU:HD21	1:A:224:VAL:HG22	2.02	0.41
1:A:408:ASN:C	1:A:408:ASN:OD1	2.63	0.41
1:A:227:ILE:HD12	1:A:227:ILE:N	2.36	0.41
1:A:237:ASP:HA	1:A:238:PRO:HD2	1.78	0.41
1:A:66:ALA:HB2	1:A:265:ILE:HD11	2.03	0.41
1:A:211:THR:O	1:A:211:THR:CG2	2.69	0.41
1:A:261:VAL:HB	1:A:262:PRO:CD	2.51	0.41

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Atom-1	Atom-2	Interatomic distance (Å)	Clash overlap (Å)
1:A:76:LEU:CD2	1:A:224:VAL:HG22	2.52	0.40
1:A:231:VAL:C	1:A:233:GLU:N	2.76	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	462/501 (92%)	406 (88%)	50 (11%)	6 (1%)	9	21

All (6) Ramachandran outliers are listed below:

Mol	Chain	Res	Type
1	A	43	VAL
1	A	228	HIS
1	A	137	THR
1	A	221	ILE
1	A	138	GLY
1	A	421	VAL

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	372/402 (92%)	331 (89%)	41 (11%)	6	12

All (41) residues with a non-rotameric sidechain are listed below:

Mol	Chain	Res	Type
1	A	13	LEU
1	A	45	ILE
1	A	96	MET
1	A	107	ILE
1	A	109	LEU
1	A	114	SER
1	A	121	GLN
1	A	144	LEU
1	A	146	ILE
1	A	161	ILE
1	A	167	MET
1	A	180	VAL
1	A	187	LEU
1	A	191	ASP
1	A	223	VAL
1	A	224	VAL
1	A	225	VAL
1	A	227	ILE
1	A	231	VAL
1	A	233	GLU
1	A	241	SER
1	A	243	GLU
1	A	276	VAL
1	A	295	SER
1	A	296	ILE
1	A	298	MET
1	A	301	LEU
1	A	303	GLN
1	A	312	SER
1	A	332	ARG
1	A	338	THR
1	A	341	ILE
1	A	364	ASN
1	A	365	LEU
1	A	397	THR
1	A	419	LEU
1	A	431	VAL
1	A	432	THR
1	A	446	ARG
1	A	456	SER
1	A	469	ILE

Sometimes sidechains can be flipped to improve hydrogen bonding and reduce clashes. All (6) such sidechains are listed below:

Mol	Chain	Res	Type
1	A	51	GLN
1	A	57	GLN
1	A	168	ASN
1	A	204	ASN
1	A	360	ASN
1	A	392	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 ⓘ

Of 2 ligands modelled in this entry, 2 are monoatomic - leaving 0 for Mogul analysis.

There are no bond length outliers.

There are no bond angle outliers.

There are no chirality outliers.

There are no torsion outliers.

There are no ring outliers.

No monomer is involved in short contacts.

5.7 Other polymers ⓘ

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 ⓘ

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	464/501 (92%)	0.38	28 (6%) 27 20	41, 57, 82, 118	0

All (28) RSRZ outliers are listed below:

Mol	Chain	Res	Type	RSRZ
1	A	457	GLU	8.2
1	A	230	ILE	5.4
1	A	358	VAL	5.0
1	A	220	TRP	4.6
1	A	229	ASP	4.5
1	A	139	PHE	4.5
1	A	9	ALA	4.2
1	A	223	VAL	4.1
1	A	10	ARG	3.8
1	A	191	ASP	2.9
1	A	431	VAL	2.8
1	A	458	ALA	2.8
1	A	386	ARG	2.7
1	A	196	GLU	2.7
1	A	194	LEU	2.7
1	A	189	GLY	2.6
1	A	320	LEU	2.5
1	A	471	PRO	2.5
1	A	242	ARG	2.5
1	A	27	VAL	2.4
1	A	36	TRP	2.3
1	A	360	ASN	2.2
1	A	170	PHE	2.1
1	A	262	PRO	2.1
1	A	188	ASP	2.1
1	A	303	GLN	2.1
1	A	131	GLU	2.1

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Mol	Chain	Res	Type	RSRZ
1	A	166	TRP	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](#)

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	NA	A	1471	1/1	0.94	0.06	60,60,60,60	0
3	HG	A	1472	1/1	0.96	0.06	112,112,112,112	1

6.5 Other polymers [i](#)

There are no such residues in this entry.