



Full wwPDB X-ray Structure Validation Report ⓘ

Mar 10, 2026 – 05:31 PM UTC

PDB ID : 6AI1 / pdb_00006ai1
Title : Structure of the 328-692 fragment of FlhA (D456V)
Authors : Ogawa, Y.; Kinoshita, M.; Minamino, T.; Imada, K.
Deposited on : 2018-08-21
Resolution : 3.50 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

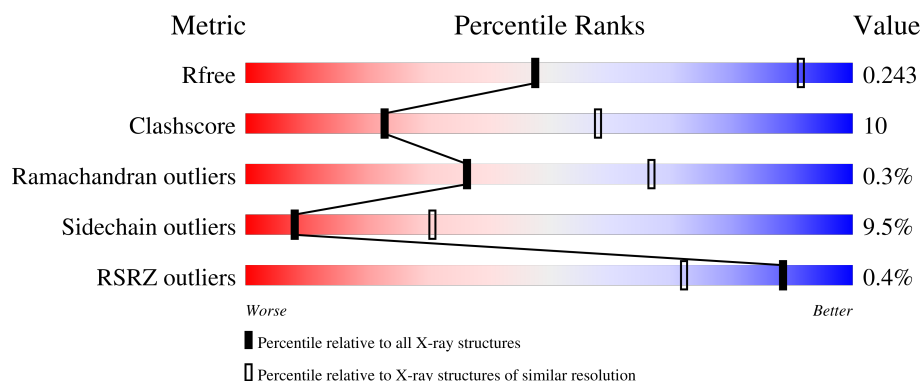
1 Overall quality at a glance

The following experimental techniques were used to determine the structure:

X-RAY DIFFRACTION

The reported resolution of this entry is 3.50 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	1085 (3.54-3.46)
Clashscore	190562	1140 (3.54-3.46)
Ramachandran outliers	187476	1113 (3.54-3.46)
Sidechain outliers	187428	1114 (3.54-3.46)
RSRZ outliers	180081	1084 (3.54-3.46)

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	369	
1	B	369	

2 Entry composition

There is only 1 type of molecule in this entry. The entry contains 5344 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 Flagellar biosynthesis protein FlhA.

Mol	Chain	Residues	Atoms					ZeroOcc	AltConf	Trace
1	A	345	Total	C	N	O	S	0	0	0
			2672	1692	476	495	9			
1	B	345	Total	C	N	O	S	0	0	0
			2672	1692	476	495	9			

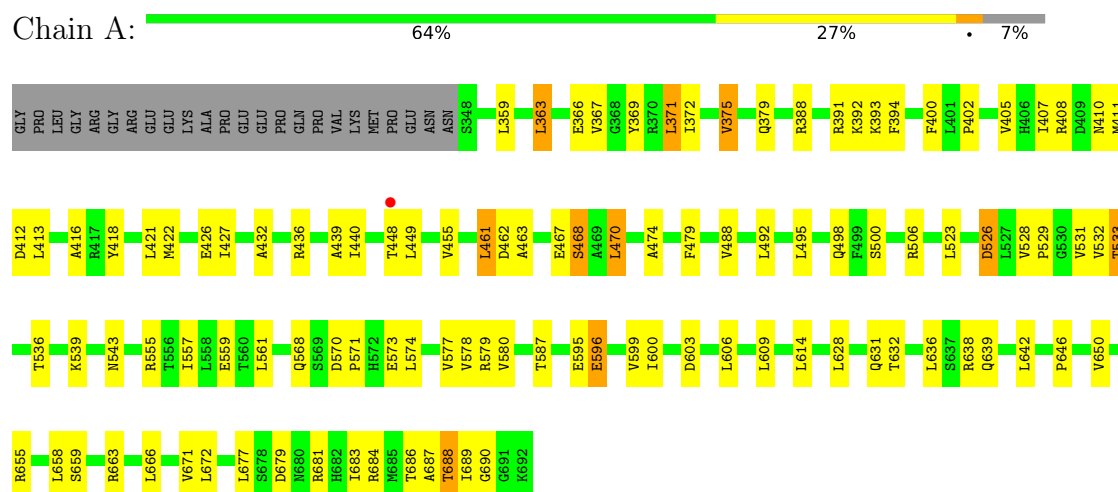
There are 10 discrepancies between the modelled and reference sequences:

Chain	Residue	Modelled	Actual	Comment	Reference
A	324	GLY	-	expression tag	UNP P40729
A	325	PRO	-	expression tag	UNP P40729
A	326	LEU	-	expression tag	UNP P40729
A	327	GLY	-	expression tag	UNP P40729
A	456	VAL	ASP	engineered mutation	UNP P40729
B	324	GLY	-	expression tag	UNP P40729
B	325	PRO	-	expression tag	UNP P40729
B	326	LEU	-	expression tag	UNP P40729
B	327	GLY	-	expression tag	UNP P40729
B	456	VAL	ASP	engineered mutation	UNP P40729

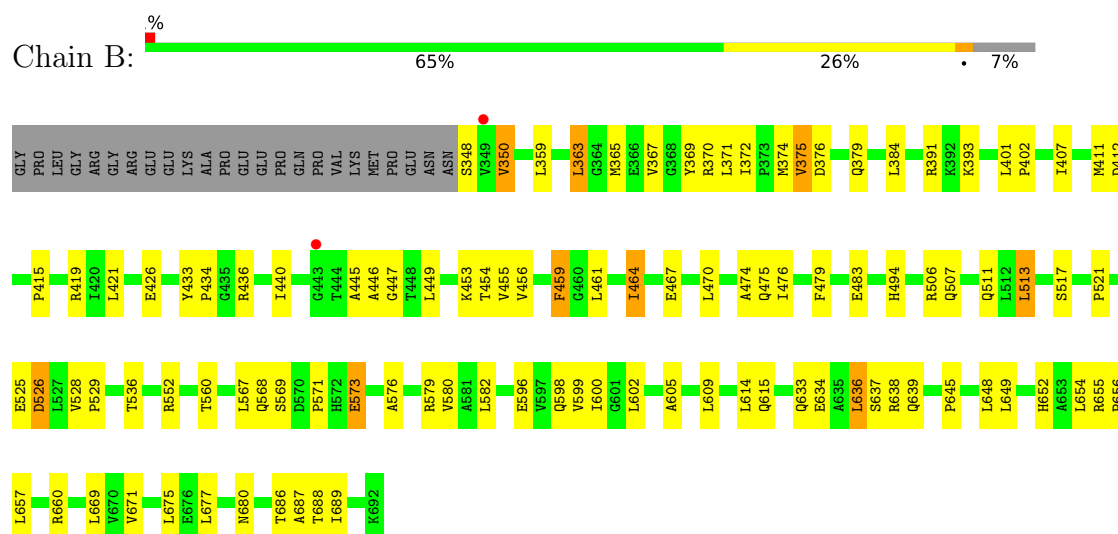
3 Residue-property plots

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: Flagellar biosynthesis protein FlhA



• Molecule 1: Flagellar biosynthesis protein FlhA



4 Data and refinement statistics

Property	Value	Source
Space group	I 41	Depositor
Cell constants a, b, c, α , β , γ	216.79Å 216.79Å 64.98Å 90.00° 90.00° 90.00°	Depositor
Resolution (Å)	54.20 – 3.50 54.20 – 3.50	Depositor EDS
% Data completeness (in resolution range)	99.8 (54.20-3.50) 99.8 (54.20-3.50)	Depositor EDS
R_{merge}	0.14	Depositor
R_{sym}	(Not available)	Depositor
$\langle I/\sigma(I) \rangle$ ¹	2.35 (at 3.48Å)	Xtriage
Refinement program	PHENIX 1.11.1_2575	Depositor
R, R_{free}	0.189 , 0.241 0.193 , 0.243	Depositor DCC
R_{free} test set	1970 reflections (10.15%)	wwPDB-VP
Wilson B-factor (Å ²)	93.7	Xtriage
Anisotropy	0.145	Xtriage
Bulk solvent k_{sol} (e/Å ³), B_{sol} (Å ²)	0.30 , 53.7	EDS
L-test for twinning ²	$\langle L \rangle = 0.46$, $\langle L^2 \rangle = 0.29$	Xtriage
Estimated twinning fraction	0.039 for -k,-h,-l	Xtriage
F_o, F_c correlation	0.94	EDS
Total number of atoms	5344	wwPDB-VP
Average B, all atoms (Å ²)	94.0	wwPDB-VP

Xtriage's analysis on translational NCS is as follows: *The largest off-origin peak in the Patterson function is 3.18% 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	0.49	0/2718	0.71	1/3691 (0.0%)
1	B	0.48	0/2718	0.72	3/3691 (0.1%)
All	All	0.49	0/5436	0.72	4/7382 (0.1%)

There are no bond length outliers.

All (4) bond angle outliers are listed below:

Mol	Chain	Res	Type	Atoms	Z	Observed(°)	Ideal(°)
1	A	498	GLN	N-CA-C	-9.19	104.15	114.62
1	B	447	GLY	N-CA-C	-8.89	100.33	111.70
1	B	445	ALA	CB-CA-C	-8.51	93.79	109.37
1	B	446	ALA	N-CA-CB	-6.37	96.73	110.88

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	A	2672	0	2739	61	0
1	B	2672	0	2739	57	0
All	All	5344	0	5478	113	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 10.

All (113) 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:536:THR:HG23	1:B:571:PRO:HG3	1.46	0.97
1:B:391:ARG:NH1	1:B:402:PRO:O	2.01	0.92
1:A:369:TYR:HB3	1:A:411:MET:HE1	1.54	0.87
1:A:536:THR:HG23	1:A:571:PRO:HG3	1.58	0.83
1:A:579:ARG:HH21	1:A:655:ARG:HD2	1.42	0.83
1:A:375:VAL:HG11	1:A:407:ILE:HG21	1.66	0.78
1:B:453:LYS:HA	1:B:464:ILE:HG13	1.68	0.75
1:A:427:ILE:HG13	1:A:495:LEU:HD13	1.69	0.73
1:A:391:ARG:NH1	1:A:402:PRO:O	2.21	0.73
1:A:363:LEU:HD13	1:A:405:VAL:HG22	1.73	0.69
1:A:526:ASP:N	1:A:526:ASP:OD1	2.27	0.68
1:B:375:VAL:HG11	1:B:407:ILE:HG21	1.76	0.68
1:A:561:LEU:HD22	1:A:574:LEU:HD13	1.76	0.66
1:A:422:MET:HB2	1:A:427:ILE:HD13	1.78	0.65
1:B:639:GLN:NE2	1:B:645:PRO:O	2.30	0.65
1:B:576:ALA:HA	1:B:579:ARG:HG3	1.80	0.64
1:B:600:ILE:HG12	1:B:687:ALA:HB3	1.79	0.64
1:B:600:ILE:HD11	1:B:639:GLN:HG3	1.79	0.64
1:A:392:LYS:NZ	1:B:350:VAL:O	2.29	0.62
1:B:569:SER:O	1:B:571:PRO:HD3	2.00	0.61
1:B:652:HIS:HB2	1:B:675:LEU:HD13	1.83	0.60
1:B:605:ALA:O	1:B:609:LEU:HG	2.03	0.59
1:B:655:ARG:HG3	1:B:671:VAL:HG12	1.84	0.59
1:B:369:TYR:HB3	1:B:411:MET:HE1	1.84	0.59
1:B:521:PRO:O	1:B:525:GLU:HG2	2.03	0.58
1:B:633:GLN:O	1:B:637:SER:OG	2.13	0.58
1:A:587:THR:OG1	1:A:677:LEU:HD23	2.04	0.57
1:A:448:THR:HG22	1:A:449:LEU:H	1.68	0.57
1:B:596:GLU:OE1	1:B:598:GLN:NE2	2.37	0.57
1:A:600:ILE:HD11	1:A:639:GLN:HG3	1.85	0.57
1:A:388:ARG:NE	1:B:348:SER:O	2.39	0.55
1:A:555:ARG:HH12	1:B:507:GLN:HB2	1.72	0.55
1:A:655:ARG:HG3	1:A:671:VAL:HG12	1.89	0.54
1:B:568:GLN:NE2	1:B:573:GLU:HG2	2.21	0.54
1:A:568:GLN:NE2	1:A:573:GLU:HG2	2.23	0.53
1:A:467:GLU:HG3	1:A:468:SER:H	1.73	0.53
1:A:600:ILE:HG12	1:A:687:ALA:HB3	1.90	0.53
1:B:449:LEU:HD11	1:B:474:ALA:HB2	1.91	0.52
1:A:359:LEU:H	1:A:359:LEU:HD12	1.75	0.52
1:B:454:THR:OG1	1:B:455:VAL:N	2.42	0.52
1:A:410:ASN:HB3	1:A:413:LEU:HD13	1.93	0.51

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Atom-1	Atom-2	Interatomic distance (Å)	Clash overlap (Å)
1:A:606:LEU:HA	1:A:609:LEU:HD12	1.93	0.50
1:A:421:LEU:HD23	1:A:426:GLU:HA	1.93	0.50
1:A:470:LEU:H	1:A:470:LEU:HD12	1.77	0.50
1:A:684:ARG:HG2	1:A:686:THR:HG23	1.94	0.50
1:A:366:GLU:HA	1:A:408:ARG:O	2.12	0.49
1:A:659:SER:OG	1:A:663:ARG:HD2	2.13	0.49
1:B:367:VAL:HG13	1:B:371:LEU:HB2	1.94	0.49
1:B:369:TYR:CE2	1:B:415:PRO:HB3	2.48	0.49
1:B:526:ASP:OD1	1:B:526:ASP:N	2.42	0.49
1:A:539:LYS:O	1:A:543:ASN:ND2	2.30	0.48
1:B:371:LEU:O	1:B:374:MET:HG2	2.13	0.48
1:B:634:GLU:OE2	1:B:638:ARG:NH2	2.40	0.48
1:B:470:LEU:HD12	1:B:470:LEU:N	2.29	0.48
1:B:369:TYR:HA	1:B:372:ILE:HG13	1.96	0.47
1:A:681:ARG:HA	1:A:681:ARG:HD2	1.66	0.47
1:B:419:ARG:HD2	1:B:426:GLU:OE1	2.15	0.47
1:B:375:VAL:HG12	1:B:384:LEU:HD21	1.97	0.47
1:A:672:LEU:HD23	1:A:672:LEU:HA	1.62	0.46
1:A:688:THR:HG22	1:A:689:ILE:H	1.79	0.46
1:A:628:LEU:O	1:A:632:THR:N	2.37	0.46
1:A:650:VAL:HG11	1:A:658:LEU:HD12	1.97	0.46
1:B:421:LEU:HD23	1:B:426:GLU:HA	1.96	0.46
1:B:365:MET:HE2	1:B:407:ILE:HG12	1.98	0.46
1:A:532:VAL:HG13	1:A:536:THR:HB	1.98	0.46
1:A:440:ILE:HD11	1:A:461:LEU:HB2	1.99	0.45
1:A:557:ILE:HG23	1:A:578:VAL:HG11	1.99	0.45
1:A:631:GLN:NE2	1:A:690:GLY:O	2.50	0.45
1:A:392:LYS:C	1:A:394:PHE:H	2.25	0.45
1:A:659:SER:O	1:A:663:ARG:HB2	2.17	0.44
1:A:474:ALA:O	1:A:479:PHE:HB2	2.17	0.44
1:B:376:ASP:HB3	1:B:379:GLN:HB2	2.00	0.44
1:A:577:VAL:O	1:A:580:VAL:HG22	2.17	0.44
1:A:555:ARG:NH1	1:B:507:GLN:HB2	2.32	0.44
1:B:474:ALA:O	1:B:479:PHE:HB2	2.18	0.44
1:A:455:VAL:HG22	1:A:462:ASP:OD2	2.18	0.43
1:A:528:VAL:HA	1:A:529:PRO:HA	1.86	0.43
1:B:433:TYR:HA	1:B:434:PRO:HD3	1.84	0.43
1:B:440:ILE:HD11	1:B:461:LEU:HD22	2.01	0.43
1:B:367:VAL:HG13	1:B:371:LEU:CB	2.49	0.42
1:B:459:PHE:CD1	1:B:459:PHE:N	2.87	0.42
1:B:600:ILE:HG22	1:B:648:LEU:HD12	2.00	0.42

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Atom-1	Atom-2	Interatomic distance (Å)	Clash overlap (Å)
1:B:636:LEU:HD23	1:B:669:LEU:HD13	2.01	0.42
1:A:579:ARG:NH2	1:A:655:ARG:HD2	2.22	0.42
1:B:513:LEU:HA	1:B:513:LEU:HD22	1.73	0.42
1:B:375:VAL:O	1:B:384:LEU:HD11	2.20	0.42
1:B:598:GLN:HG2	1:B:686:THR:HG21	2.01	0.42
1:A:367:VAL:HG13	1:A:371:LEU:CB	2.50	0.42
1:A:559:GLU:HG2	1:B:506:ARG:HB3	2.01	0.42
1:B:528:VAL:HA	1:B:529:PRO:HA	1.90	0.42
1:B:599:VAL:HG11	1:B:649:LEU:HD22	2.01	0.41
1:B:552:ARG:HE	1:B:552:ARG:HB3	1.56	0.41
1:A:439:ALA:O	1:A:463:ALA:HB1	2.20	0.41
1:B:363:LEU:HD23	1:B:363:LEU:HA	1.79	0.41
1:B:602:LEU:HA	1:B:689:ILE:HB	2.03	0.41
1:A:638:ARG:O	1:A:642:LEU:HG	2.21	0.41
1:A:596:GLU:HG3	1:A:684:ARG:NH2	2.36	0.41
1:A:394:PHE:HE1	1:A:400:PHE:CE1	2.39	0.41
1:A:418:TYR:CE2	1:A:488:VAL:HG22	2.56	0.41
1:A:561:LEU:CD2	1:A:574:LEU:HD13	2.45	0.41
1:A:570:ASP:HB3	1:A:573:GLU:HB2	2.02	0.41
1:A:574:LEU:HA	1:A:574:LEU:HD23	1.72	0.41
1:B:507:GLN:O	1:B:511:GLN:HG3	2.20	0.41
1:A:595:GLU:H	1:A:595:GLU:HG2	1.56	0.41
1:A:416:ALA:HB1	1:A:432:ALA:O	2.21	0.40
1:B:449:LEU:HD23	1:B:449:LEU:HA	1.85	0.40
1:A:679:ASP:C	1:A:681:ARG:H	2.29	0.40
1:A:628:LEU:HA	1:A:628:LEU:HD23	1.58	0.40
1:B:614:LEU:HD12	1:B:654:LEU:HD23	2.03	0.40
1:B:494:HIS:CD2	1:B:494:HIS:C	2.99	0.40
1:B:655:ARG:HB3	1:B:656:PRO:HD3	2.02	0.40
1:A:533:THR:O	1:A:536:THR:N	2.54	0.40
1:B:582:LEU:HA	1:B:582:LEU:HD23	1.87	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	343/369 (93%)	313 (91%)	28 (8%)	2 (1%)	21	54
1	B	343/369 (93%)	314 (92%)	29 (8%)	0	100	100
All	All	686/738 (93%)	627 (91%)	57 (8%)	2 (0%)	36	67

All (2) Ramachandran outliers are listed below:

Mol	Chain	Res	Type
1	A	379	GLN
1	A	646	PRO

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	288/308 (94%)	263 (91%)	25 (9%)	9	33
1	B	288/308 (94%)	258 (90%)	30 (10%)	7	27
All	All	576/616 (94%)	521 (90%)	55 (10%)	8	31

All (55) residues with a non-rotameric sidechain are listed below:

Mol	Chain	Res	Type
1	A	363	LEU
1	A	371	LEU
1	A	372	ILE
1	A	375	VAL
1	A	393	LYS
1	A	412	ASP
1	A	436	ARG
1	A	461	LEU
1	A	468	SER
1	A	470	LEU
1	A	492	LEU

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Mol	Chain	Res	Type
1	A	500	SER
1	A	506	ARG
1	A	523	LEU
1	A	526	ASP
1	A	531	VAL
1	A	533	THR
1	A	596	GLU
1	A	599	VAL
1	A	603	ASP
1	A	614	LEU
1	A	636	LEU
1	A	666	LEU
1	A	683	ILE
1	A	688	THR
1	B	350	VAL
1	B	359	LEU
1	B	363	LEU
1	B	370	ARG
1	B	375	VAL
1	B	393	LYS
1	B	401	LEU
1	B	412	ASP
1	B	436	ARG
1	B	456	VAL
1	B	459	PHE
1	B	464	ILE
1	B	467	GLU
1	B	475	GLN
1	B	476	ILE
1	B	483	GLU
1	B	513	LEU
1	B	517	SER
1	B	526	ASP
1	B	560	THR
1	B	567	LEU
1	B	573	GLU
1	B	580	VAL
1	B	615	GLN
1	B	636	LEU
1	B	657	LEU
1	B	660	ARG
1	B	677	LEU

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Mol	Chain	Res	Type
1	B	680	ASN
1	B	688	THR

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	414	GLN
1	A	588	GLN
1	A	631	GLN
1	A	680	ASN
1	B	542	GLN
1	B	589	GLN
1	B	598	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	345/369 (93%)	-0.29	1 (0%) 90 76	48, 89, 143, 172	0
1	B	345/369 (93%)	-0.22	2 (0%) 85 65	50, 91, 150, 180	0
All	All	690/738 (93%)	-0.25	3 (0%) 88 72	48, 90, 148, 180	0

All (3) RSRZ outliers are listed below:

Mol	Chain	Res	Type	RSRZ
1	B	443	GLY	2.3
1	A	448	THR	2.3
1	B	349	VAL	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](#)

There are no ligands in this entry.

6.5 Other polymers [i](#)

There are no such residues in this entry.