



Full wwPDB X-ray Structure Validation Report ⓘ

Mar 12, 2026 – 03:25 PM UTC

PDB ID : 8YZW / pdb_00008yzw
Title : The structure of HLA-A*2402 complex with peptide from SARS-CoV-2 S448-456 NYDYWYRLF(BA.2.86)
Authors : Liu, J.; Tian, J.M.; Shang, B.L.
Deposited on : 2024-04-08
Resolution : 2.36 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

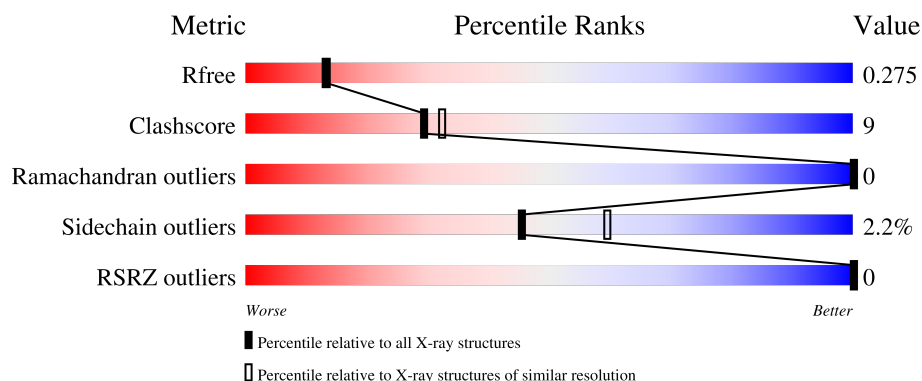
1 Overall quality at a glance

The following experimental techniques were used to determine the structure:

X-RAY DIFFRACTION

The reported resolution of this entry is 2.36 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	1596 (2.36-2.36)
Clashscore	190562	1663 (2.36-2.36)
Ramachandran outliers	187476	1646 (2.36-2.36)
Sidechain outliers	187428	1646 (2.36-2.36)
RSRZ outliers	180081	1598 (2.36-2.36)

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	274	80% 19%
1	D	274	84% 16%
2	B	100	78% 21% .
2	E	100	77% 22% .
3	C	9	44% 44% 11%

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Mol	Chain	Length	Quality of chain
3	F	9	 67% 33%

2 Entry composition [i](#)

There are 4 unique types of molecules in this entry. The entry contains 6542 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 MHC class I antigen.

Mol	Chain	Residues	Atoms					ZeroOcc	AltConf	Trace
1	D	274	Total	C	N	O	S	0	0	0
			2222	1382	403	427	10			
1	A	274	Total	C	N	O	S	0	0	0
			2222	1382	403	427	10			

- Molecule 2 is a protein called Beta-2-microglobulin.

Mol	Chain	Residues	Atoms					ZeroOcc	AltConf	Trace
2	E	100	Total	C	N	O	S	0	0	0
			837	533	141	159	4			
2	B	100	Total	C	N	O	S	0	0	0
			837	533	141	159	4			

There are 2 discrepancies between the modelled and reference sequences:

Chain	Residue	Modelled	Actual	Comment	Reference
E	0	MET	-	initiating methionine	UNP P61769
B	0	MET	-	initiating methionine	UNP P61769

- Molecule 3 is a protein called Spike protein S2'.

Mol	Chain	Residues	Atoms				ZeroOcc	AltConf	Trace
3	F	9	Total	C	N	O	0	0	0
			97	67	14	16			
3	C	9	Total	C	N	O	0	0	0
			97	67	14	16			

There are 4 discrepancies between the modelled and reference sequences:

Chain	Residue	Modelled	Actual	Comment	Reference
F	3	ASP	ASN	conflict	UNP P0DTC2
F	5	TRP	LEU	conflict	UNP P0DTC2

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Chain	Residue	Modelled	Actual	Comment	Reference
C	3	ASP	ASN	conflict	UNP P0DTC2
C	5	TRP	LEU	conflict	UNP P0DTC2

- Molecule 4 is water.

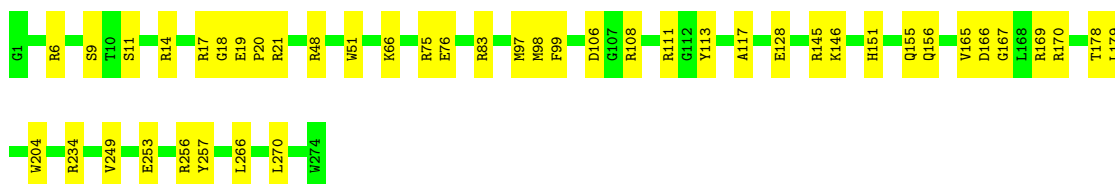
Mol	Chain	Residues	Atoms		ZeroOcc	AltConf
4	D	79	Total	O	0	0
			79	79		
4	E	31	Total	O	0	0
			31	31		
4	F	5	Total	O	0	0
			5	5		
4	A	72	Total	O	0	0
			72	72		
4	B	38	Total	O	0	0
			38	38		
4	C	5	Total	O	0	0
			5	5		

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.

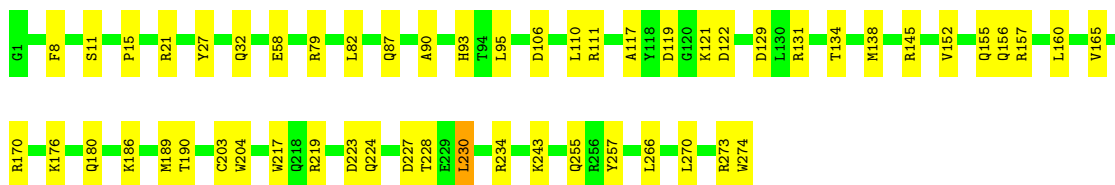
- Molecule 1: MHC class I antigen

Chain D:  84% 16%



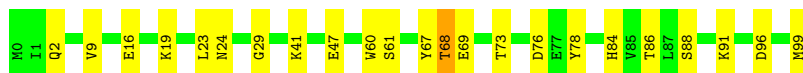
- Molecule 1: MHC class I antigen

Chain A:  80% 19%



- Molecule 2: Beta-2-microglobulin

Chain E:  77% 22%



- Molecule 2: Beta-2-microglobulin

Chain B:  78% 21%



- Molecule 3: Spike protein S2'

Chain F:  67% 33%



- Molecule 3: Spike protein S2'

Chain C:  44% 44% 11%



4 Data and refinement statistics

Property	Value	Source
Space group	P 1	Depositor
Cell constants a, b, c, α , β , γ	50.23Å 65.51Å 87.10Å 111.94° 90.08° 90.15°	Depositor
Resolution (Å)	32.12 – 2.36 32.12 – 2.36	Depositor EDS
% Data completeness (in resolution range)	92.8 (32.12-2.36) 91.9 (32.12-2.36)	Depositor EDS
R_{merge}	(Not available)	Depositor
R_{sym}	(Not available)	Depositor
$\langle I/\sigma(I) \rangle$ ¹	1.82 (at 2.37Å)	Xtriage
Refinement program	PHENIX (1.20.1_4487: ???)	Depositor
R, R_{free}	0.216 , 0.278 0.216 , 0.275	Depositor DCC
R_{free} test set	1993 reflections (4.69%)	wwPDB-VP
Wilson B-factor (Å ²)	23.4	Xtriage
Anisotropy	0.383	Xtriage
Bulk solvent k_{sol} (e/Å ³), B_{sol} (Å ²)	0.36 , 16.4	EDS
L-test for twinning ²	$\langle L \rangle = 0.48$, $\langle L^2 \rangle = 0.32$	Xtriage
Estimated twinning fraction	0.030 for h,-k,-l 0.359 for -h,k,-k-l 0.026 for -h,-k,k+l	Xtriage
F_o, F_c correlation	0.92	EDS
Total number of atoms	6542	wwPDB-VP
Average B, all atoms (Å ²)	25.0	wwPDB-VP

Xtriage's analysis on translational NCS is as follows: *The largest off-origin peak in the Patterson function is 5.42% 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	0.37	0/2282	0.57	0/3092
1	D	0.38	0/2282	0.57	0/3092
2	B	0.39	0/860	0.58	0/1162
2	E	0.40	0/860	0.60	0/1162
3	C	0.38	0/102	0.45	0/137
3	F	0.34	0/102	0.53	0/137
All	All	0.38	0/6488	0.57	0/8782

There are no bond length outliers.

There are no bond angle outliers.

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	2222	0	2082	38	0
1	D	2222	0	2082	36	0
2	B	837	0	803	20	0
2	E	837	0	803	17	0
3	C	97	0	82	6	0
3	F	97	0	82	3	0
4	A	72	0	0	4	0
4	B	38	0	0	0	0
4	C	5	0	0	0	0
4	D	79	0	0	3	0

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Mol	Chain	Non-H	H(model)	H(added)	Clashes	Symm-Clashes
4	E	31	0	0	3	0
4	F	5	0	0	0	0
All	All	6542	0	5934	105	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 9.

All (105) 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:170:ARG:HH22	3:C:1:ASN:HD21	1.26	0.80
2:B:7:ILE:HD12	2:B:91:LYS:HD3	1.64	0.79
1:D:6:ARG:HD2	1:D:98:MET:HE3	1.65	0.77
1:A:79:ARG:NH2	4:A:302:HOH:O	2.24	0.71
1:D:6:ARG:CD	1:D:98:MET:HE3	2.20	0.71
1:A:157:ARG:HH11	1:A:157:ARG:HG2	1.56	0.70
1:D:106:ASP:OD1	1:D:108:ARG:HG2	1.94	0.68
1:D:14:ARG:NH2	1:D:19:GLU:O	2.28	0.67
1:A:266:LEU:HD13	1:A:270:LEU:HG	1.77	0.64
1:A:82:LEU:HD13	1:A:87:GLN:HB2	1.80	0.64
1:A:15:PRO:HG2	1:A:90:ALA:O	1.98	0.63
1:D:20:PRO:HG2	1:D:75:ARG:HG3	1.80	0.62
1:D:98:MET:HE1	1:D:113:TYR:HB2	1.82	0.62
1:A:255:GLN:O	1:A:273:ARG:NH1	2.32	0.62
1:A:170:ARG:HH22	3:C:1:ASN:ND2	1.99	0.60
1:D:17:ARG:N	4:D:306:HOH:O	2.36	0.59
1:D:51:TRP:CZ2	1:D:179:LEU:HD11	2.40	0.57
1:A:219:ARG:HD3	1:A:257:TYR:CZ	2.40	0.57
1:A:224:GLN:O	1:A:228:THR:OG1	2.22	0.57
1:A:234:ARG:HH12	2:B:99:MET:HG2	1.69	0.57
2:B:74:GLU:H	2:B:74:GLU:CD	2.11	0.56
1:D:249:VAL:HG22	1:D:257:TYR:CZ	2.40	0.56
1:A:230:LEU:HD22	1:A:243:LYS:HE3	1.88	0.56
2:E:96:ASP:O	2:E:99:MET:HE3	2.06	0.55
1:D:66:LYS:HG2	3:F:4:TYR:CE1	2.42	0.55
2:B:74:GLU:OE1	2:B:74:GLU:N	2.28	0.54
1:D:111:ARG:HG2	1:D:113:TYR:CZ	2.43	0.54
1:D:266:LEU:HD13	1:D:270:LEU:HG	1.89	0.54
1:A:157:ARG:HG2	1:A:157:ARG:NH1	2.22	0.53
1:A:155:GLN:HE22	3:C:7:ARG:HE	1.56	0.53
1:D:167:GLY:HA2	1:D:170:ARG:HH12	1.73	0.53

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Atom-1	Atom-2	Interatomic distance (Å)	Clash overlap (Å)
2:E:2:GLN:NE2	4:E:103:HOH:O	2.34	0.52
1:D:204:TRP:HH2	2:E:99:MET:SD	2.31	0.52
1:D:167:GLY:HA2	1:D:170:ARG:NH1	2.25	0.52
1:A:11:SER:HA	1:A:21:ARG:O	2.10	0.52
2:B:25:CYS:HB2	2:B:39:LEU:HD21	1.92	0.52
2:B:7:ILE:CD1	2:B:91:LYS:HD3	2.37	0.51
3:F:5:TRP:CH2	3:F:7:ARG:HB2	2.44	0.51
1:A:145:ARG:NH1	4:A:310:HOH:O	2.42	0.51
1:D:166:ASP:OD1	1:D:169:ARG:NH1	2.37	0.51
1:A:203:CYS:HB2	1:A:217:TRP:CZ2	2.45	0.51
2:B:10:TYR:HB2	2:B:99:MET:HE2	1.93	0.51
1:A:129:ASP:N	4:A:312:HOH:O	2.46	0.49
1:D:234:ARG:HH12	2:E:99:MET:HG2	1.78	0.48
1:A:131:ARG:NH2	4:A:313:HOH:O	2.46	0.48
1:D:66:LYS:HG2	3:F:4:TYR:CZ	2.49	0.47
1:D:98:MET:HE2	1:D:99:PHE:C	2.39	0.47
2:E:47:GLU:OE2	4:E:101:HOH:O	2.20	0.47
1:D:18:GLY:N	4:D:306:HOH:O	2.36	0.47
2:E:9:VAL:O	2:E:99:MET:HE2	2.15	0.47
2:B:51:HIS:HA	2:B:65:LEU:O	2.14	0.47
3:C:5:TRP:CH2	3:C:7:ARG:HB2	2.50	0.46
2:E:16:GLU:OE1	2:E:19:LYS:HB3	2.15	0.46
1:A:121:LYS:HD2	1:A:122:ASP:O	2.16	0.46
1:D:20:PRO:HD2	1:D:75:ARG:HD2	1.96	0.46
1:A:156:GLN:NE2	3:C:3:ASP:OD2	2.48	0.46
1:A:189:MET:HE1	1:A:274:TRP:HB2	1.97	0.46
2:E:41:LYS:HG3	2:E:78:TYR:CE1	2.51	0.45
2:E:88:SER:OG	2:B:15:ALA:O	2.33	0.45
1:A:110:LEU:HD23	1:A:110:LEU:HA	1.61	0.45
1:D:253:GLU:CD	1:D:256:ARG:HE	2.25	0.45
1:D:11:SER:HA	1:D:21:ARG:O	2.17	0.45
1:D:249:VAL:HG22	1:D:257:TYR:CE2	2.52	0.45
1:A:138:MET:HE3	1:A:138:MET:HB3	1.83	0.45
1:A:160:LEU:HD23	1:A:160:LEU:HA	1.70	0.45
1:A:189:MET:HE3	1:A:217:TRP:HH2	1.82	0.45
1:A:93:HIS:ND1	1:A:119:ASP:OD2	2.47	0.45
2:E:68:THR:HG23	2:E:69:GLU:O	2.17	0.45
1:A:176:LYS:HA	1:A:180:GLN:HG3	1.98	0.44
1:A:8:PHE:HB3	2:B:56:PHE:CZ	2.53	0.44
2:E:84:HIS:ND1	2:E:86:THR:HG23	2.32	0.44
3:C:3:ASP:OD1	3:C:4:TYR:N	2.49	0.44

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Atom-1	Atom-2	Interatomic distance (Å)	Clash overlap (Å)
1:D:151:HIS:O	1:D:155:GLN:HG3	2.18	0.44
1:D:111:ARG:CD	1:D:128:GLU:HG3	2.47	0.44
2:E:73:THR:OG1	2:E:76:ASP:OD2	2.33	0.44
1:A:95:LEU:HD12	1:A:117:ALA:O	2.17	0.43
1:D:111:ARG:HD2	1:D:128:GLU:HG3	1.99	0.43
1:D:75:ARG:NH1	1:D:75:ARG:HG2	2.34	0.43
1:D:146:LYS:HA	1:D:146:LYS:HD3	1.90	0.43
2:B:21:ASN:HB3	2:B:70:PHE:CE1	2.53	0.43
1:D:106:ASP:CG	1:D:108:ARG:HG2	2.44	0.43
1:D:111:ARG:NE	1:D:128:GLU:HG3	2.34	0.43
2:E:91:LYS:NZ	4:E:107:HOH:O	2.52	0.43
2:E:9:VAL:HA	2:E:24:ASN:O	2.19	0.42
1:A:8:PHE:HD2	2:B:56:PHE:CE1	2.38	0.42
1:A:106:ASP:OD1	1:A:106:ASP:N	2.50	0.42
1:A:27:TYR:CZ	1:A:32:GLN:HB2	2.55	0.42
1:D:48:ARG:HA	1:D:48:ARG:HD2	1.82	0.42
1:D:145:ARG:HA	4:D:332:HOH:O	2.19	0.42
1:D:9:SER:OG	1:D:97:MET:HB3	2.19	0.41
1:D:117:ALA:HB2	2:E:60:TRP:CE2	2.55	0.41
1:A:58:GLU:HA	1:A:58:GLU:OE1	2.20	0.41
2:B:10:TYR:CB	2:B:99:MET:HE2	2.50	0.41
1:A:121:LYS:HB3	1:A:121:LYS:HE3	1.79	0.41
1:A:204:TRP:HH2	2:B:99:MET:SD	2.43	0.41
2:B:1:ILE:HG12	2:B:2:GLN:O	2.21	0.41
2:B:55:SER:HB3	2:B:63:TYR:CZ	2.56	0.41
1:A:190:THR:HG21	2:B:98:ASP:OD1	2.21	0.41
2:B:40:LEU:HD23	2:B:45:ARG:HA	2.03	0.41
2:E:29:GLY:HA2	2:E:61:SER:OG	2.21	0.41
1:A:227:ASP:OD1	1:A:227:ASP:N	2.53	0.41
1:D:98:MET:HE1	1:D:113:TYR:CB	2.50	0.40
2:B:10:TYR:HA	2:B:99:MET:HE2	2.02	0.40
2:B:77:GLU:OE1	2:B:94:LYS:HB3	2.22	0.40
2:E:23:LEU:O	2:E:67:TYR:HA	2.21	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	272/274 (99%)	263 (97%)	9 (3%)	0	100	100
1	D	272/274 (99%)	261 (96%)	11 (4%)	0	100	100
2	B	98/100 (98%)	96 (98%)	2 (2%)	0	100	100
2	E	98/100 (98%)	94 (96%)	4 (4%)	0	100	100
3	C	7/9 (78%)	7 (100%)	0	0	100	100
3	F	7/9 (78%)	7 (100%)	0	0	100	100
All	All	754/766 (98%)	728 (97%)	26 (3%)	0	100	100

There are no Ramachandran outliers to report.

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	230/230 (100%)	223 (97%)	7 (3%)	36	48
1	D	230/230 (100%)	225 (98%)	5 (2%)	45	59
2	B	95/95 (100%)	94 (99%)	1 (1%)	65	79
2	E	95/95 (100%)	94 (99%)	1 (1%)	65	79
3	C	9/9 (100%)	8 (89%)	1 (11%)	6	5
3	F	9/9 (100%)	9 (100%)	0	100	100
All	All	668/668 (100%)	653 (98%)	15 (2%)	45	59

All (15) residues with a non-rotameric sidechain are listed below:

Mol	Chain	Res	Type
1	D	76	GLU
1	D	83	ARG
1	D	156	GLN
1	D	165	VAL
1	D	178	THR
2	E	68	THR
1	A	111	ARG
1	A	134	THR
1	A	152	VAL
1	A	165	VAL
1	A	186	LYS
1	A	223	ASP
1	A	230	LEU
2	B	70	PHE
3	C	7	ARG

Sometimes sidechains can be flipped to improve hydrogen bonding and reduce clashes. All (9) such sidechains are listed below:

Mol	Chain	Res	Type
1	D	72	GLN
1	D	151	HIS
1	D	192	HIS
1	D	255	GLN
2	E	8	GLN
1	A	155	GLN
1	A	192	HIS
2	B	13	HIS
3	C	1	ASN

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 [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	274/274 (100%)	-1.48	0 100 100	14, 24, 44, 56	0
1	D	274/274 (100%)	-1.46	0 100 100	14, 24, 44, 66	0
2	B	100/100 (100%)	-1.50	0 100 100	13, 22, 39, 62	0
2	E	100/100 (100%)	-1.50	0 100 100	14, 22, 39, 53	0
3	C	9/9 (100%)	-1.52	0 100 100	16, 21, 26, 29	0
3	F	9/9 (100%)	-1.48	0 100 100	18, 21, 28, 30	0
All	All	766/766 (100%)	-1.48	0 100 100	13, 23, 43, 66	0

There are no RSRZ outliers to report.

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.