



wwPDB X-ray Structure Validation Summary Report ⓘ

Mar 8, 2026 – 12:47 PM UTC

PDB ID : 4EUP / pdb_00004eup
Title : The complex between TCR JKF6 and human Class I MHC HLA-A2 presenting the MART-1(27-35)(A27L) peptide
Authors : Hossain, M.; Baker, B.M.
Deposited on : 2012-04-25
Resolution : 2.88 Å(reported)

This is a wwPDB X-ray Structure Validation Summary 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

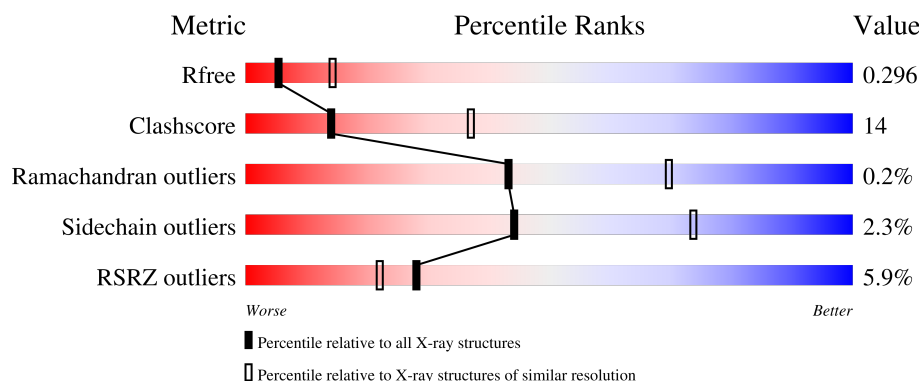
1 Overall quality at a glance

The following experimental techniques were used to determine the structure:

X-RAY DIFFRACTION

The reported resolution of this entry is 2.88 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	3557 (2.90-2.86)
Clashscore	190562	3801 (2.90-2.86)
Ramachandran outliers	187476	3699 (2.90-2.86)
Sidechain outliers	187428	3702 (2.90-2.86)
RSRZ outliers	180081	3558 (2.90-2.86)

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	275	<div> <div>5%</div> <div> <div></div> <div>72%</div> <div>22%</div> <div>• •</div> </div> </div>
1	D	275	<div> <div>5%</div> <div> <div></div> <div>69%</div> <div>24%</div> <div>• •</div> </div> </div>
2	B	100	<div> <div>2%</div> <div> <div></div> <div>67%</div> <div>33%</div> </div> </div>
2	E	100	<div> <div></div> <div> <div></div> <div>80%</div> <div>20%</div> </div> </div>
3	C	9	<div> <div></div> <div> <div></div> <div>56%</div> <div>33%</div> <div>11%</div> </div> </div>

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Mol	Chain	Length	Quality of chain
3	F	9	<div><div></div><div>67%</div><div>33%</div></div>
4	G	206	<div><div>8%</div><div>73%</div><div>23%</div><div>..</div></div>
4	I	206	<div><div>16%</div><div>73%</div><div>23%</div><div>..</div></div>
5	H	243	<div><div>3%</div><div>74%</div><div>24%</div><div>.</div></div>
5	J	243	<div><div>5%</div><div>68%</div><div>28%</div><div>..</div></div>

2 Entry composition

There are 6 unique types of molecules in this entry. The entry contains 13167 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 HLA class I histocompatibility antigen, A-2 alpha chain.

Mol	Chain	Residues	Atoms					ZeroOcc	AltConf	Trace
1	D	265	Total	C	N	O	S	0	0	0
			2164	1359	394	402	9			
1	A	267	Total	C	N	O	S	0	0	0
			2183	1369	399	406	9			

- 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
			836	533	141	158	4			
2	B	100	Total	C	N	O	S	0	0	0
			836	533	141	158	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 Melanoma antigen recognized by T-cells 1.

Mol	Chain	Residues	Atoms				ZeroOcc	AltConf	Trace
3	F	9	Total	C	N	O	0	0	0
			60	40	9	11			
3	C	9	Total	C	N	O	0	0	0
			60	40	9	11			

There are 2 discrepancies between the modelled and reference sequences:

Chain	Residue	Modelled	Actual	Comment	Reference
F	2	LEU	ALA	engineered mutation	UNP Q16655
C	2	LEU	ALA	engineered mutation	UNP Q16655

- Molecule 4 is a protein called JKF6 alpha chain.

Mol	Chain	Residues	Atoms					ZeroOcc	AltConf	Trace
4	G	201	Total	C	N	O	S	0	0	0
			1537	955	255	319	8			
4	I	201	Total	C	N	O	S	0	0	0
			1537	955	255	319	8			

- Molecule 5 is a protein called JKF6 beta chain.

Mol	Chain	Residues	Atoms					ZeroOcc	AltConf	Trace
5	H	241	Total	C	N	O	S	0	0	0
			1938	1229	330	370	9			
5	J	240	Total	C	N	O	S	0	0	0
			1930	1225	329	367	9			

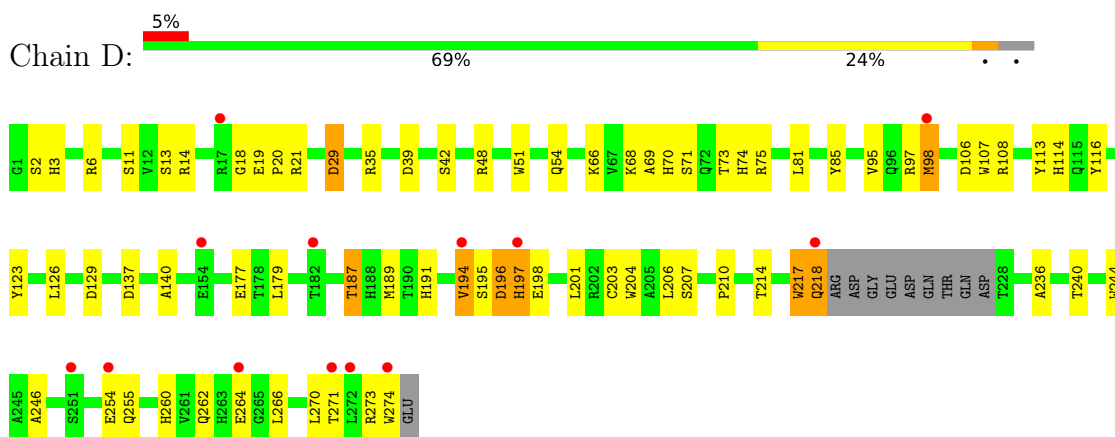
- Molecule 6 is water.

Mol	Chain	Residues	Atoms		ZeroOcc	AltConf
6	D	13	Total	O	0	0
			13	13		
6	E	9	Total	O	0	0
			9	9		
6	A	10	Total	O	0	0
			10	10		
6	B	12	Total	O	0	0
			12	12		
6	G	10	Total	O	0	0
			10	10		
6	I	5	Total	O	0	0
			5	5		
6	H	13	Total	O	0	0
			13	13		
6	J	14	Total	O	0	0
			14	14		

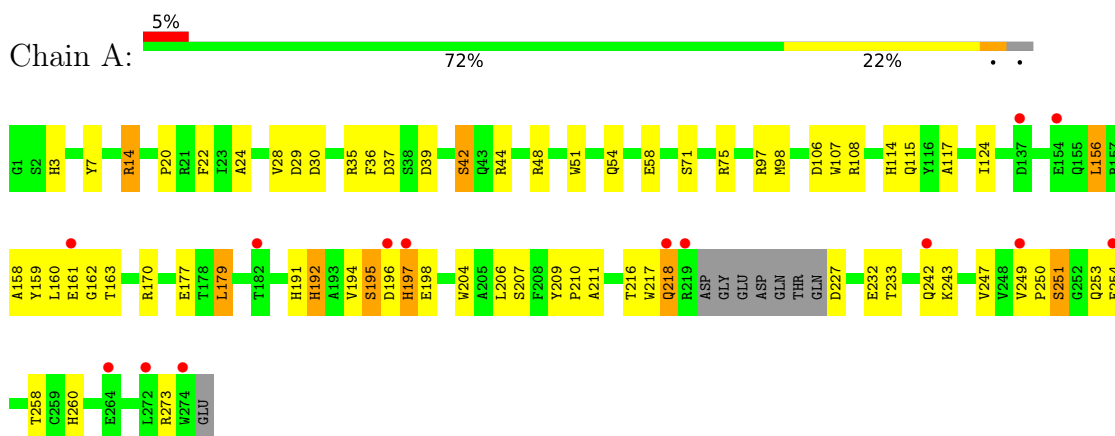
3 Residue-property plots [i](#)

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.

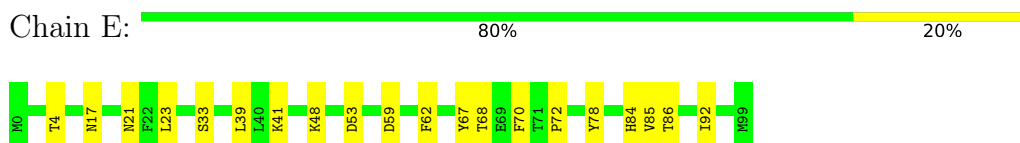
- Molecule 1: HLA class I histocompatibility antigen, A-2 alpha chain



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- Molecule 2: Beta-2-microglobulin



- Molecule 2: Beta-2-microglobulin



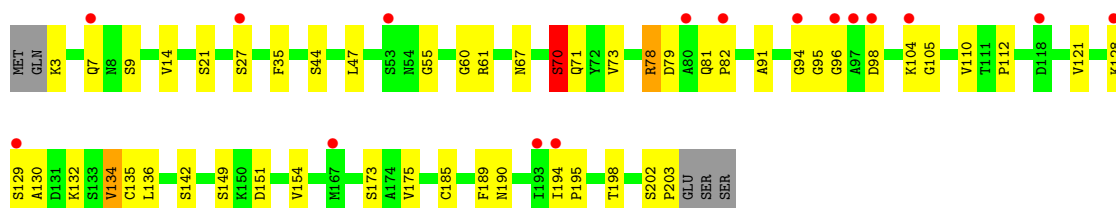
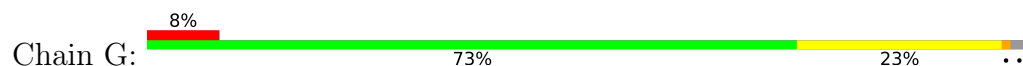
- Molecule 3: Melanoma antigen recognized by T-cells 1



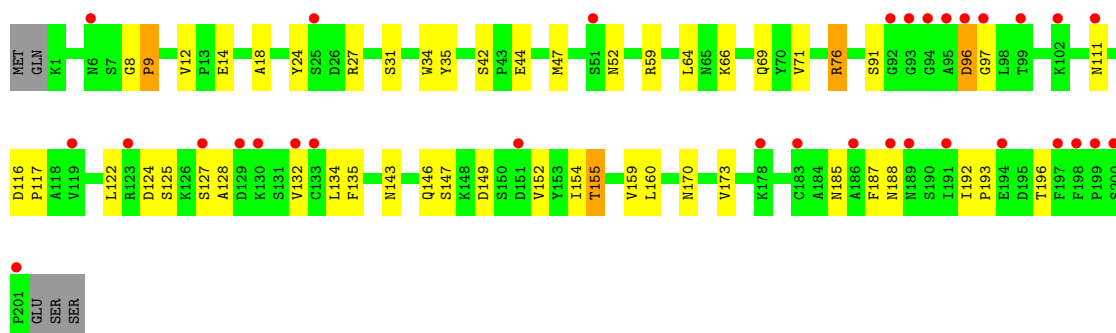
- Molecule 3: Melanoma antigen recognized by T-cells 1



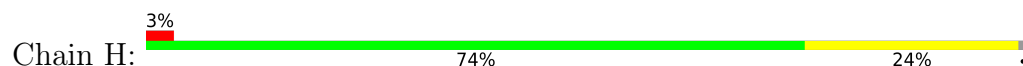
- Molecule 4: JKF6 alpha chain



- Molecule 4: JKF6 alpha chain



- Molecule 5: JKF6 beta chain





● Molecule 5: JKF6 beta chain



4 Data and refinement statistics

Property	Value	Source
Space group	P 1 21 1	Depositor
Cell constants a, b, c, α , β , γ	127.66Å 53.70Å 150.51Å 90.00° 112.46° 90.00°	Depositor
Resolution (Å)	20.00 – 2.88 20.00 – 2.88	Depositor EDS
% Data completeness (in resolution range)	92.6 (20.00-2.88) 92.2 (20.00-2.88)	Depositor EDS
R_{merge}	0.07	Depositor
R_{sym}	(Not available)	Depositor
$\langle I/\sigma(I) \rangle$ ¹	2.59 (at 2.88Å)	Xtriage
Refinement program	REFMAC 5.5.0110	Depositor
R, R_{free}	0.235 , 0.295 0.242 , 0.296	Depositor DCC
R_{free} test set	2170 reflections (5.02%)	wwPDB-VP
Wilson B-factor (Å ²)	45.9	Xtriage
Anisotropy	0.089	Xtriage
Bulk solvent k_{sol} (e/Å ³), B_{sol} (Å ²)	0.35 , 56.5	EDS
L-test for twinning ²	$\langle L \rangle = 0.49$, $\langle L^2 \rangle = 0.32$	Xtriage
Estimated twinning fraction	0.000 for h,-k,-h-l	Xtriage
F_o, F_c correlation	0.91	EDS
Total number of atoms	13167	wwPDB-VP
Average B, all atoms (Å ²)	52.0	wwPDB-VP

Xtriage's analysis on translational NCS is as follows: *The analyses of the Patterson function reveals a significant off-origin peak that is 36.21 % of the origin peak, indicating pseudo-translational symmetry. The chance of finding a peak of this or larger height randomly in a structure without pseudo-translational symmetry is equal to 5.1727e-04. The detected translational NCS is most likely also responsible for the elevated intensity ratio.*

¹ Intensities estimated from amplitudes.

² Theoretical 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

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	0.93	0/2247	1.06	9/3049 (0.3%)
1	D	0.92	1/2228 (0.0%)	1.21	14/3024 (0.5%)
2	B	0.92	0/859	1.01	1/1162 (0.1%)
2	E	0.90	0/859	0.96	1/1162 (0.1%)
3	C	1.06	0/59	1.16	1/78 (1.3%)
3	F	1.09	0/59	1.34	1/78 (1.3%)
4	G	0.81	0/1569	1.02	9/2128 (0.4%)
4	I	0.81	0/1569	0.99	7/2128 (0.3%)
5	H	0.73	0/1988	0.90	0/2696
5	J	0.75	0/1980	0.96	7/2685 (0.3%)
All	All	0.85	1/13417 (0.0%)	1.03	50/18190 (0.3%)

All (1) bond length outliers are listed below:

Mol	Chain	Res	Type	Atoms	Z	Observed(Å)	Ideal(Å)
1	D	217	TRP	C-N	-8.20	1.21	1.33

The worst 5 of 50 bond angle outliers are listed below:

Mol	Chain	Res	Type	Atoms	Z	Observed(°)	Ideal(°)
1	D	217	TRP	O-C-N	-18.55	101.41	123.29
1	D	217	TRP	CA-C-N	13.44	145.89	121.70
1	D	217	TRP	C-N-CA	13.44	145.89	121.70
5	J	214	TYR	CB-CA-C	-8.85	99.44	112.09
4	I	97	GLY	N-CA-C	-8.51	93.00	113.18

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	2183	0	2049	62	0
1	D	2164	0	2031	75	0
2	B	836	0	803	34	0
2	E	836	0	803	19	0
3	C	60	0	73	6	0
3	F	60	0	73	4	0
4	G	1537	0	1448	43	0
4	I	1537	0	1451	39	0
5	H	1938	0	1862	60	0
5	J	1930	0	1858	63	0
6	A	10	0	0	0	0
6	B	12	0	0	0	0
6	D	13	0	0	1	0
6	E	9	0	0	0	0
6	G	10	0	0	0	0
6	H	13	0	0	0	0
6	I	5	0	0	0	0
6	J	14	0	0	1	0
All	All	13167	0	12451	366	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 14.

The worst 5 of 366 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:D:196:ASP:HB3	1:D:197:HIS:CD2	1.39	1.55
1:D:196:ASP:CB	1:D:197:HIS:HD2	1.47	1.26
4:G:7:GLN:NE2	4:G:105:GLY:H	1.36	1.24
1:D:196:ASP:CB	1:D:197:HIS:CD2	2.21	1.21
1:D:35:ARG:HD3	2:E:53:ASP:OD1	1.42	1.17

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	263/275 (96%)	242 (92%)	19 (7%)	2 (1%)	16	41
1	D	261/275 (95%)	245 (94%)	16 (6%)	0	100	100
2	B	98/100 (98%)	94 (96%)	4 (4%)	0	100	100
2	E	98/100 (98%)	94 (96%)	4 (4%)	0	100	100
3	C	7/9 (78%)	5 (71%)	2 (29%)	0	100	100
3	F	7/9 (78%)	6 (86%)	1 (14%)	0	100	100
4	G	199/206 (97%)	179 (90%)	19 (10%)	1 (0%)	24	51
4	I	199/206 (97%)	187 (94%)	12 (6%)	0	100	100
5	H	239/243 (98%)	228 (95%)	10 (4%)	1 (0%)	30	56
5	J	238/243 (98%)	221 (93%)	17 (7%)	0	100	100
All	All	1609/1666 (97%)	1501 (93%)	104 (6%)	4 (0%)	43	70

All (4) Ramachandran outliers are listed below:

Mol	Chain	Res	Type
1	A	195	SER
5	H	219	ALA
1	A	251	SER
4	G	95	GLY

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	224/231 (97%)	217 (97%)	7 (3%)	35	66
1	D	222/231 (96%)	218 (98%)	4 (2%)	51	78
2	B	95/95 (100%)	94 (99%)	1 (1%)	65	86
2	E	95/95 (100%)	93 (98%)	2 (2%)	47	75
3	C	6/6 (100%)	6 (100%)	0	100	100
3	F	6/6 (100%)	6 (100%)	0	100	100
4	G	174/179 (97%)	168 (97%)	6 (3%)	32	64
4	I	174/179 (97%)	168 (97%)	6 (3%)	32	64
5	H	212/214 (99%)	210 (99%)	2 (1%)	70	88
5	J	211/214 (99%)	206 (98%)	5 (2%)	43	73
All	All	1419/1450 (98%)	1386 (98%)	33 (2%)	44	74

5 of 33 residues with a non-rotameric sidechain are listed below:

Mol	Chain	Res	Type
5	J	12	VAL
5	J	17	GLU
5	J	230	VAL
1	A	232	GLU
1	A	197	HIS

Sometimes sidechains can be flipped to improve hydrogen bonding and reduce clashes. 5 of 38 such sidechains are listed below:

Mol	Chain	Res	Type
4	I	188	ASN
5	H	201	GLN
4	I	189	ASN
5	H	117	ASN
5	J	201	GLN

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	267/275 (97%)	-0.08	14 (5%) 33 26	18, 37, 65, 84	5 (1%)
1	D	265/275 (96%)	-0.01	13 (4%) 35 28	15, 35, 73, 91	5 (1%)
2	B	100/100 (100%)	-0.30	2 (2%) 65 57	21, 34, 54, 75	1 (1%)
2	E	100/100 (100%)	-0.34	0 100 100	21, 33, 53, 72	1 (1%)
3	C	9/9 (100%)	-0.38	0 100 100	36, 38, 38, 39	0
3	F	9/9 (100%)	-0.42	0 100 100	29, 31, 33, 34	0
4	G	201/206 (97%)	0.81	16 (7%) 18 15	34, 63, 98, 107	2 (0%)
4	I	201/206 (97%)	0.99	32 (15%) 5 4	34, 65, 119, 144	3 (1%)
5	H	241/243 (99%)	0.37	7 (2%) 53 45	39, 56, 77, 91	0
5	J	240/243 (98%)	0.58	12 (5%) 34 27	40, 61, 93, 115	0
All	All	1633/1666 (98%)	0.30	96 (5%) 28 22	15, 50, 93, 144	17 (1%)

The worst 5 of 96 RSRZ outliers are listed below:

Mol	Chain	Res	Type	RSRZ
4	I	201	PRO	6.4
4	G	98	ASP	5.5
5	J	215	GLY	4.8
4	I	96	ASP	4.7
4	I	95	ALA	4.6

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.