



wwPDB X-ray Structure Validation Summary Report ⓘ

Mar 8, 2026 – 02:46 PM UTC

PDB ID : 9GV6 / pdb_00009gv6
Title : Structure of TCR in complex with peptide-HLA
Authors : Karuppiah, V.
Deposited on : 2024-09-23
Resolution : 2.77 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

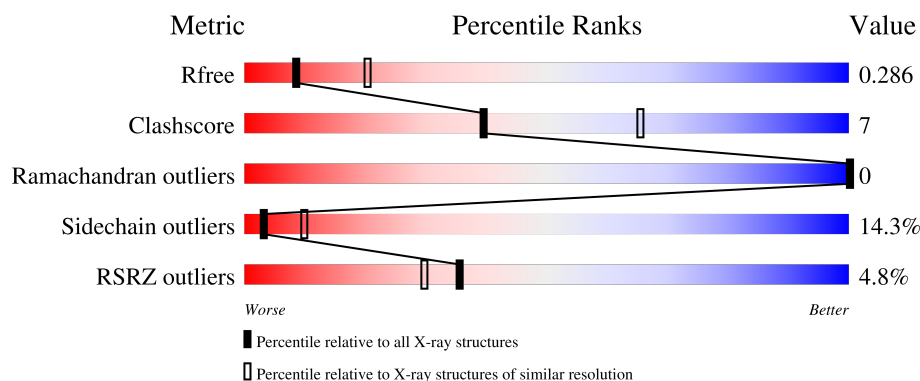
1 Overall quality at a glance

The following experimental techniques were used to determine the structure:

X-RAY DIFFRACTION

The reported resolution of this entry is 2.77 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	5248 (2.80-2.76)
Clashscore	190562	5693 (2.80-2.76)
Ramachandran outliers	187476	5590 (2.80-2.76)
Sidechain outliers	187428	5592 (2.80-2.76)
RSRZ outliers	180081	5251 (2.80-2.76)

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	276	2% 75% 21% • •
1	G	276	4% 75% 19% 5% •
2	B	100	8% 82% 13% 5%
2	H	100	3% 83% 14% • •
3	C	9	11% 33% 44% 22%

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Mol	Chain	Length	Quality of chain
3	I	9	44%44%11%
4	D	196	5% 67%22%5% • 6%
4	J	196	9% 68%20%5% • 6%
5	E	247	3% 72%22% • •
5	K	247	5% 70%22%6% •

2 Entry composition [i](#)

There are 6 unique types of molecules in this entry. The entry contains 13165 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	A	276	Total	C	N	O	S	0	0	0
			2254	1408	410	427	9			
1	G	276	Total	C	N	O	S	0	0	0
			2254	1408	410	427	9			

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

Mol	Chain	Residues	Atoms					ZeroOcc	AltConf	Trace
2	B	100	Total	C	N	O	S	0	0	0
			837	533	141	159	4			
2	H	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
B	0	MET	-	initiating methionine	UNP P61769
H	0	MET	-	initiating methionine	UNP P61769

- Molecule 3 is a protein called Peptide.

Mol	Chain	Residues	Atoms				ZeroOcc	AltConf	Trace
3	C	9	Total	C	N	O	0	0	0
			79	52	13	14			
3	I	9	Total	C	N	O	0	0	0
			79	52	13	14			

- Molecule 4 is a protein called TCR alpha.

Mol	Chain	Residues	Atoms					ZeroOcc	AltConf	Trace
4	D	185	Total	C	N	O	S	0	0	0
			1452	911	242	290	9			

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Mol	Chain	Residues	Atoms					ZeroOcc	AltConf	Trace
4	J	185	Total	C	N	O	S	0	0	0
			1452	911	242	290	9			

- Molecule 5 is a protein called TCR Beta.

Mol	Chain	Residues	Atoms					ZeroOcc	AltConf	Trace
5	E	245	Total	C	N	O	S	0	0	0
			1955	1241	341	368	5			
5	K	245	Total	C	N	O	S	0	0	0
			1955	1241	341	368	5			

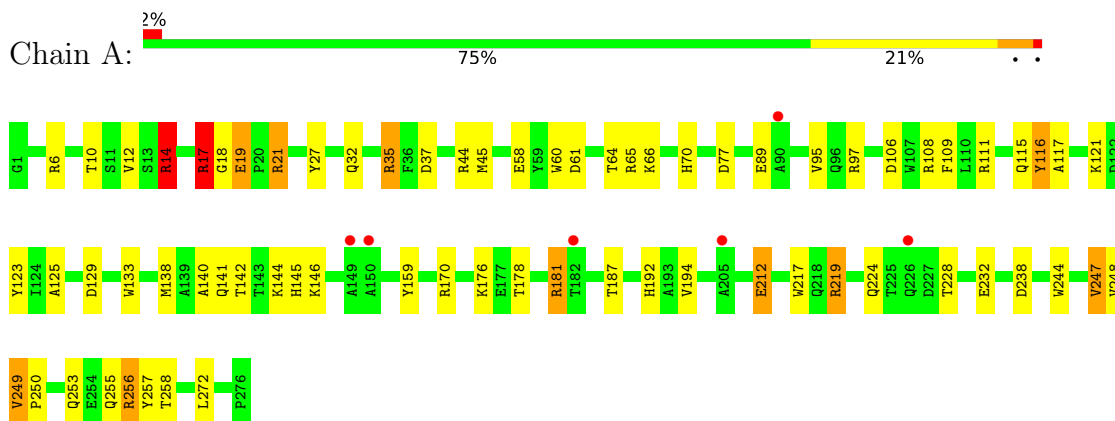
- Molecule 6 is water.

Mol	Chain	Residues	Atoms		ZeroOcc	AltConf
6	A	6	Total	O	0	0
			6	6		
6	B	1	Total	O	0	0
			1	1		
6	D	1	Total	O	0	0
			1	1		
6	E	1	Total	O	0	0
			1	1		
6	K	2	Total	O	0	0
			2	2		

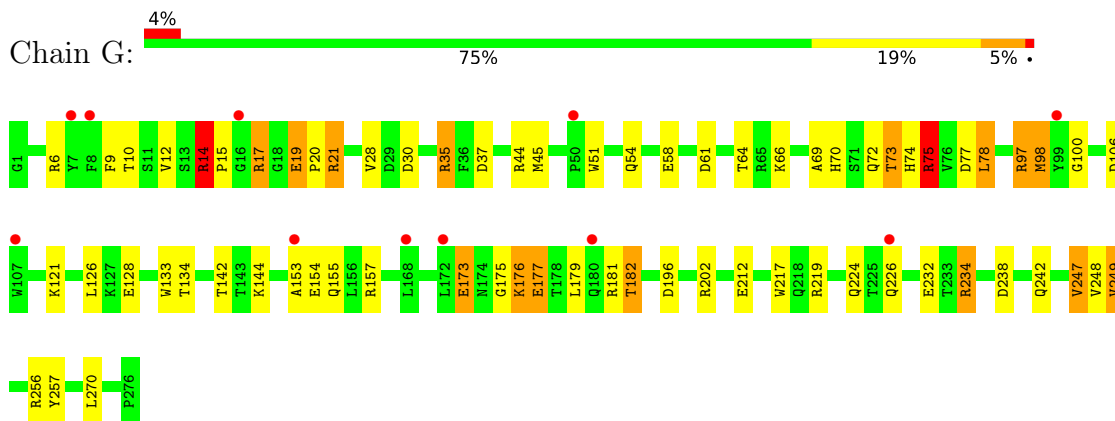
3 Residue-property plots [i](#)

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.

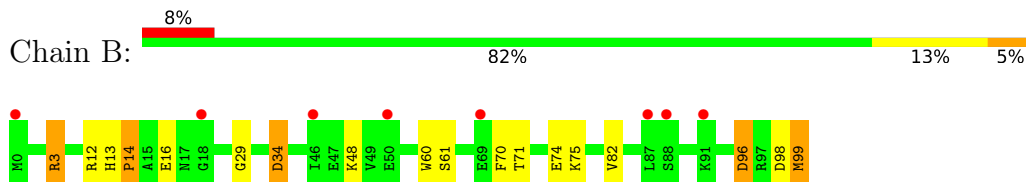
- Molecule 1: MHC class I antigen



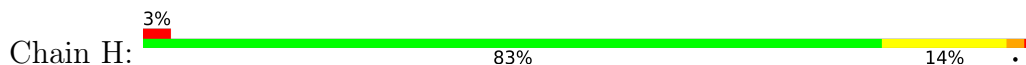
- Molecule 1: MHC class I antigen

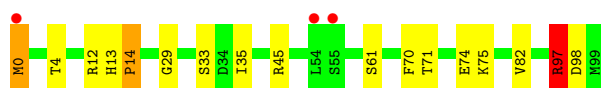


- Molecule 2: Beta-2-microglobulin

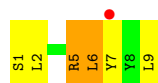


- Molecule 2: Beta-2-microglobulin





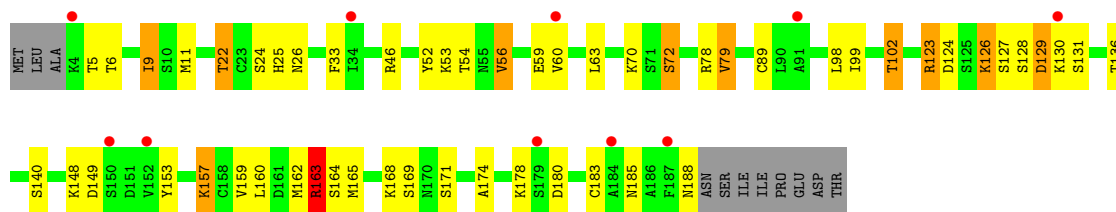
- Molecule 3: Peptide



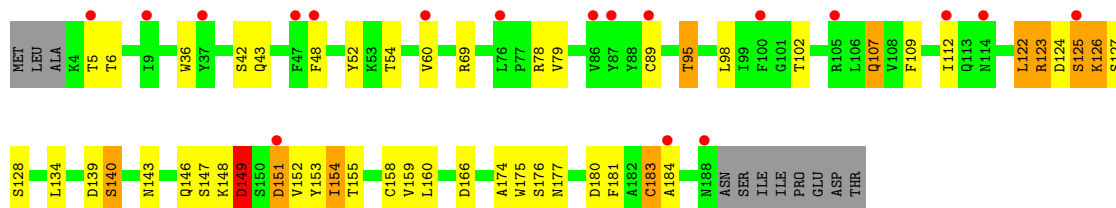
- Molecule 3: Peptide



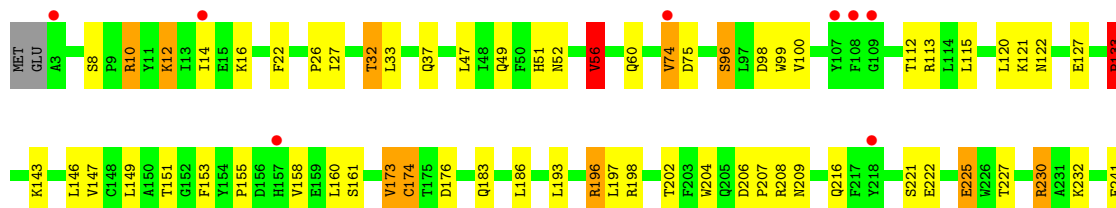
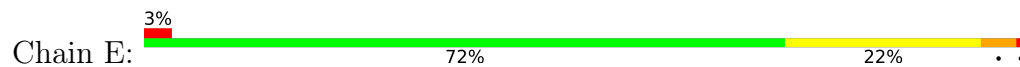
- Molecule 4: TCR alpha



- Molecule 4: TCR alpha

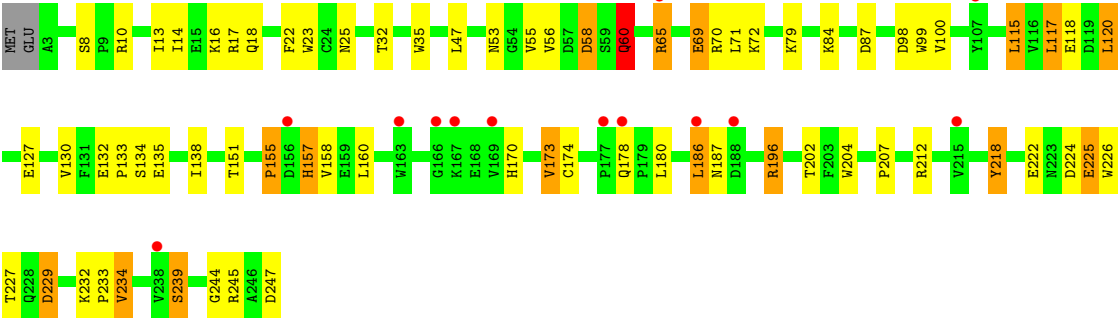


- Molecule 5: TCR Beta





• Molecule 5: TCR Beta



4 Data and refinement statistics

Property	Value	Source
Space group	P 21 21 21	Depositor
Cell constants a, b, c, α , β , γ	74.12Å 93.53Å 388.95Å 90.00° 90.00° 90.00°	Depositor
Resolution (Å)	90.94 – 2.77 90.94 – 2.77	Depositor EDS
% Data completeness (in resolution range)	99.3 (90.94-2.77) 97.6 (90.94-2.77)	Depositor EDS
R_{merge}	0.21	Depositor
R_{sym}	(Not available)	Depositor
$\langle I/\sigma(I) \rangle$ ¹	1.01 (at 2.77Å)	Xtriage
Refinement program	REFMAC 5.8.0425	Depositor
R, R_{free}	0.217 , 0.274 0.237 , 0.286	Depositor DCC
R_{free} test set	3492 reflections (5.01%)	wwPDB-VP
Wilson B-factor (Å ²)	87.9	Xtriage
Anisotropy	0.552	Xtriage
Bulk solvent k_{sol} (e/Å ³), B_{sol} (Å ²)	0.32 , 83.2	EDS
L-test for twinning ²	$\langle L \rangle = 0.51$, $\langle L^2 \rangle = 0.34$	Xtriage
Estimated twinning fraction	No twinning to report.	Xtriage
F_o, F_c correlation	0.92	EDS
Total number of atoms	13165	wwPDB-VP
Average B, all atoms (Å ²)	109.0	wwPDB-VP

Xtriage's analysis on translational NCS is as follows: *The largest off-origin peak in the Patterson function is 3.65% 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

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	0.65	0/2320	1.19	7/3149 (0.2%)
1	G	0.64	0/2320	1.14	8/3149 (0.3%)
2	B	0.63	0/860	1.14	4/1162 (0.3%)
2	H	0.64	0/860	1.06	2/1162 (0.2%)
3	C	0.77	0/80	1.22	1/107 (0.9%)
3	I	0.65	0/80	1.25	0/107
4	D	0.80	0/1486	1.26	5/2019 (0.2%)
4	J	0.68	0/1486	1.21	5/2019 (0.2%)
5	E	0.74	0/2009	1.29	7/2734 (0.3%)
5	K	0.70	0/2009	1.23	10/2734 (0.4%)
All	All	0.69	0/13510	1.20	49/18342 (0.3%)

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	7
1	G	0	6
2	B	0	2
2	H	0	2
3	C	0	1
3	I	0	1
4	D	0	3
5	E	0	4
5	K	0	4
All	All	0	30

There are no bond length outliers.

The worst 5 of 49 bond angle outliers are listed below:

Mol	Chain	Res	Type	Atoms	Z	Observed(°)	Ideal(°)
5	E	74	VAL	CB-CA-C	-7.82	98.47	111.29
5	E	74	VAL	N-CA-C	7.70	125.36	109.34
2	B	96	ASP	CA-CB-CG	6.79	119.39	112.60
1	A	61	ASP	CA-CB-CG	6.63	119.23	112.60
1	G	61	ASP	CA-CB-CG	6.62	119.22	112.60

There are no chirality outliers.

5 of 30 planarity outliers are listed below:

Mol	Chain	Res	Type	Group
1	A	14	ARG	Sidechain
1	A	17	ARG	Sidechain
1	A	170	ARG	Sidechain
1	A	181	ARG	Sidechain
1	A	35	ARG	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	2254	0	2103	31	0
1	G	2254	0	2103	32	0
2	B	837	0	805	8	0
2	H	837	0	805	4	0
3	C	79	0	82	4	0
3	I	79	0	82	5	0
4	D	1452	0	1372	18	0
4	J	1452	0	1372	25	0
5	E	1955	0	1880	30	0
5	K	1955	0	1880	31	0
6	A	6	0	0	0	0
6	B	1	0	0	0	0
6	D	1	0	0	0	0
6	E	1	0	0	0	0
6	K	2	0	0	0	0
All	All	13165	0	12484	167	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 7.

The worst 5 of 167 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)
5:E:26:PRO:CD	5:E:74:VAL:O	2.22	0.88
5:E:10:ARG:HB2	5:E:10:ARG:HH11	1.41	0.86
4:D:52:TYR:CE2	4:D:53:LYS:HD2	2.27	0.70
5:K:232:LYS:HG2	5:K:234:VAL:HG13	1.74	0.69
1:G:249:VAL:HG22	1:G:257:TYR:CZ	2.29	0.68

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	274/276 (99%)	256 (93%)	18 (7%)	0	100	100
1	G	274/276 (99%)	250 (91%)	24 (9%)	0	100	100
2	B	98/100 (98%)	91 (93%)	7 (7%)	0	100	100
2	H	98/100 (98%)	92 (94%)	6 (6%)	0	100	100
3	C	7/9 (78%)	6 (86%)	1 (14%)	0	100	100
3	I	7/9 (78%)	6 (86%)	1 (14%)	0	100	100
4	D	183/196 (93%)	160 (87%)	23 (13%)	0	100	100
4	J	183/196 (93%)	167 (91%)	16 (9%)	0	100	100
5	E	243/247 (98%)	227 (93%)	16 (7%)	0	100	100
5	K	243/247 (98%)	223 (92%)	20 (8%)	0	100	100
All	All	1610/1656 (97%)	1478 (92%)	132 (8%)	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	232/232 (100%)	203 (88%)	29 (12%)	4	13
1	G	232/232 (100%)	203 (88%)	29 (12%)	4	13
2	B	95/95 (100%)	87 (92%)	8 (8%)	10	29
2	H	95/95 (100%)	84 (88%)	11 (12%)	5	16
3	C	9/9 (100%)	8 (89%)	1 (11%)	6	18
3	I	9/9 (100%)	8 (89%)	1 (11%)	6	18
4	D	166/176 (94%)	134 (81%)	32 (19%)	1	4
4	J	166/176 (94%)	141 (85%)	25 (15%)	3	8
5	E	211/213 (99%)	178 (84%)	33 (16%)	2	8
5	K	211/213 (99%)	176 (83%)	35 (17%)	2	7
All	All	1426/1450 (98%)	1222 (86%)	204 (14%)	3	10

5 of 204 residues with a non-rotameric sidechain are listed below:

Mol	Chain	Res	Type
1	G	121	LYS
3	I	6	LEU
5	K	225	GLU
1	G	173	GLU
1	G	249	VAL

Sometimes sidechains can be flipped to improve hydrogen bonding and reduce clashes. 5 of 20 such sidechains are listed below:

Mol	Chain	Res	Type
1	G	192	HIS
4	J	111	ASN
5	K	228	GLN
5	K	7	GLN
4	D	43	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	276/276 (100%)	0.06	6 (2%) 62 55	65, 97, 141, 179	0
1	G	276/276 (100%)	0.40	11 (3%) 42 36	104, 124, 149, 171	0
2	B	100/100 (100%)	0.31	8 (8%) 18 14	76, 101, 134, 146	0
2	H	100/100 (100%)	0.33	3 (3%) 52 45	105, 132, 165, 183	0
3	C	9/9 (100%)	0.66	1 (11%) 10 8	73, 75, 80, 83	0
3	I	9/9 (100%)	0.64	0 100 100	92, 101, 112, 122	0
4	D	185/196 (94%)	0.43	10 (5%) 31 26	62, 88, 159, 202	0
4	J	185/196 (94%)	0.71	18 (9%) 13 10	30, 120, 173, 196	0
5	E	245/247 (99%)	0.15	8 (3%) 49 42	63, 86, 135, 174	1 (0%)
5	K	245/247 (99%)	0.45	13 (5%) 32 26	75, 104, 143, 175	1 (0%)
All	All	1630/1656 (98%)	0.34	78 (4%) 35 30	30, 109, 154, 202	2 (0%)

The worst 5 of 78 RSRZ outliers are listed below:

Mol	Chain	Res	Type	RSRZ
5	K	167	LYS	5.8
4	J	114	ASN	5.0
5	K	163	TRP	4.4
5	K	166	GLY	4.3
4	J	105	ARG	4.3

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.