



wwPDB X-ray Structure Validation Summary Report ⓘ

Mar 9, 2026 – 05:31 AM UTC

PDB ID : 5M2I / pdb_00005m2i
Title : Structure of human Tumor Necrosis Factor (TNF) in complex with the Llama VHH1
Authors : Cambillau, C.; Spinelli, S.; Desmyter, A.; de Haard, H.
Deposited on : 2016-10-13
Resolution : 2.15 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

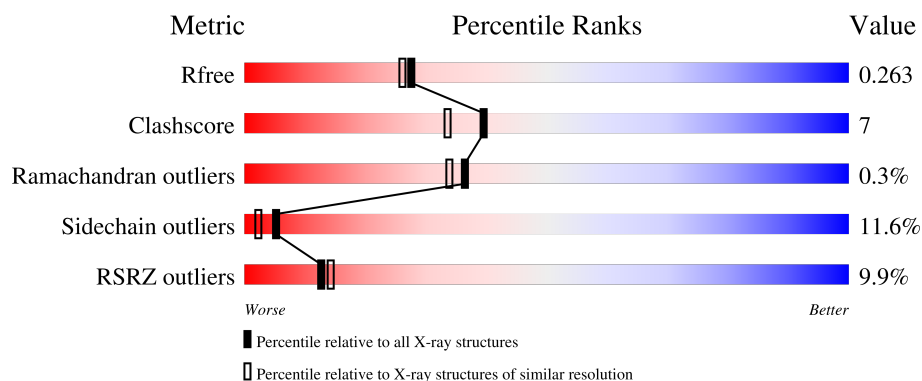
1 Overall quality at a glance

The following experimental techniques were used to determine the structure:

X-RAY DIFFRACTION

The reported resolution of this entry is 2.15 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	2057 (2.16-2.16)
Clashscore	190562	2159 (2.16-2.16)
Ramachandran outliers	187476	2134 (2.16-2.16)
Sidechain outliers	187428	2133 (2.16-2.16)
RSRZ outliers	180081	2059 (2.16-2.16)

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	157	9% 70% 22% 6%
1	B	157	17% 64% 25% 6%
1	C	157	15% 66% 25% 6%
1	D	157	11% 68% 24% 6%
1	E	157	22% 66% 23% 7%

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Mol	Chain	Length	Quality of chain
1	F	157	
2	G	121	
2	H	121	
2	I	121	
2	J	121	
2	K	121	
2	L	121	

2 Entry composition

There are 3 unique types of molecules in this entry. The entry contains 13256 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 Tumor necrosis factor.

Mol	Chain	Residues	Atoms					ZeroOcc	AltConf	Trace
1	A	148	Total	C	N	O	S	0	0	0
			1139	730	193	214	2			
1	B	148	Total	C	N	O	S	0	0	0
			1136	730	193	211	2			
1	C	148	Total	C	N	O	S	0	0	0
			1153	738	197	216	2			
1	D	148	Total	C	N	O	S	0	0	0
			1143	732	193	216	2			
1	E	146	Total	C	N	O	S	0	0	0
			1121	721	191	207	2			
1	F	148	Total	C	N	O	S	0	0	0
			1153	738	197	216	2			

- Molecule 2 is a protein called VHH1.

Mol	Chain	Residues	Atoms					ZeroOcc	AltConf	Trace
2	G	121	Total	C	N	O	S	0	0	0
			944	595	163	182	4			
2	H	121	Total	C	N	O	S	0	0	0
			944	595	163	182	4			
2	I	121	Total	C	N	O	S	0	0	0
			944	595	163	182	4			
2	J	121	Total	C	N	O	S	0	0	0
			944	595	163	182	4			
2	K	121	Total	C	N	O	S	0	0	0
			944	595	163	182	4			
2	L	121	Total	C	N	O	S	0	0	0
			944	595	163	182	4			

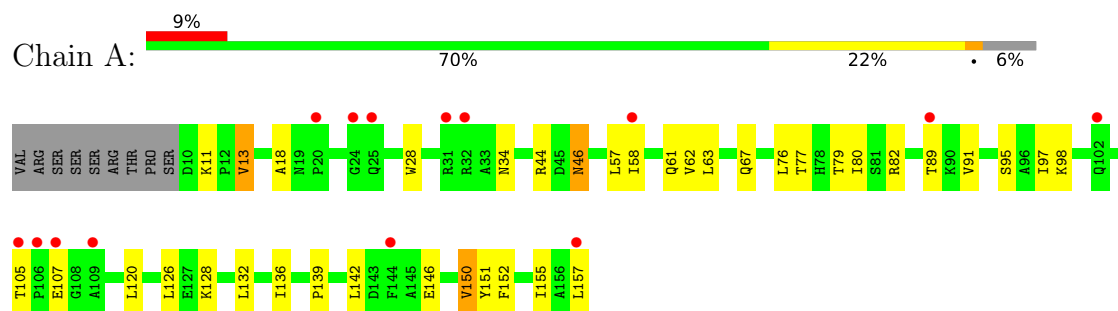
- Molecule 3 is water.

Mol	Chain	Residues	Atoms		ZeroOcc	AltConf
3	A	52	Total 52	O 52	0	0
3	B	51	Total 51	O 51	0	0
3	C	55	Total 55	O 55	0	0
3	D	56	Total 56	O 56	0	0
3	E	37	Total 37	O 37	0	0
3	F	60	Total 60	O 60	0	0
3	G	78	Total 78	O 78	0	0
3	H	59	Total 59	O 59	0	0
3	I	79	Total 79	O 79	0	0
3	J	95	Total 95	O 95	0	0
3	K	48	Total 48	O 48	0	0
3	L	77	Total 77	O 77	0	0

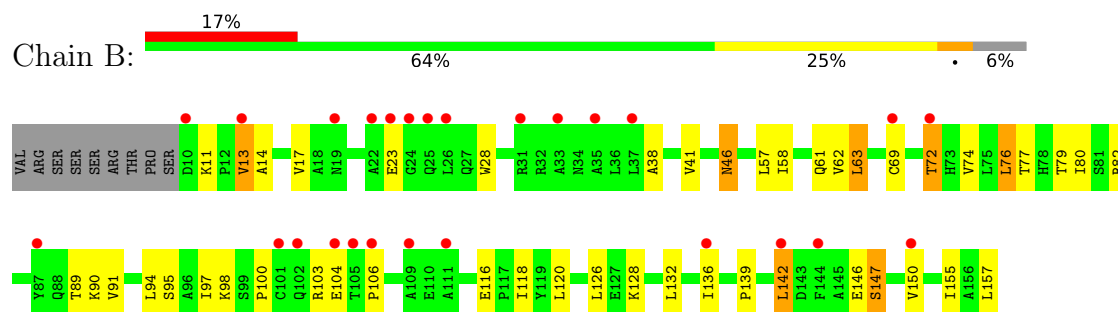
3 Residue-property plots [i](#)

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.

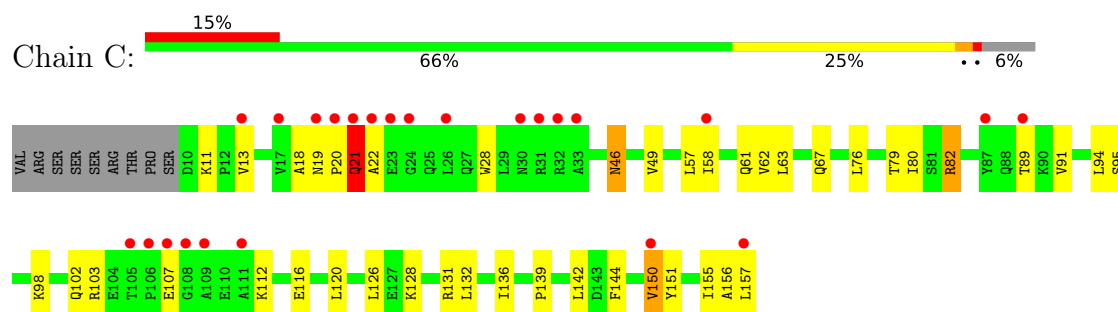
- Molecule 1: Tumor necrosis factor



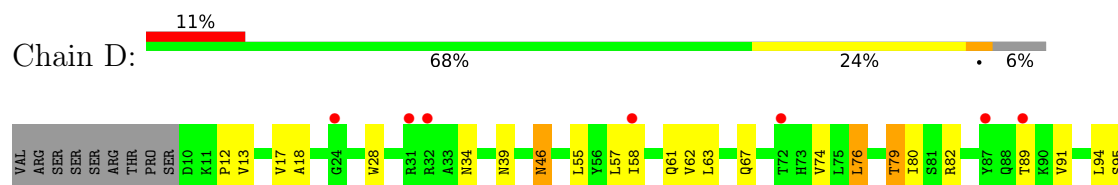
- Molecule 1: Tumor necrosis factor



- Molecule 1: Tumor necrosis factor

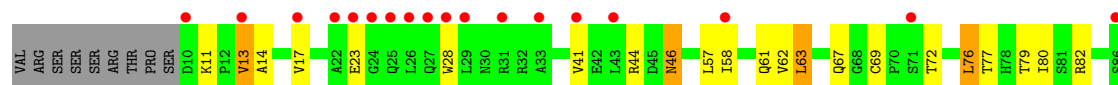


- Molecule 1: Tumor necrosis factor

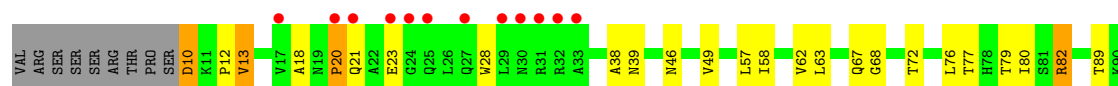




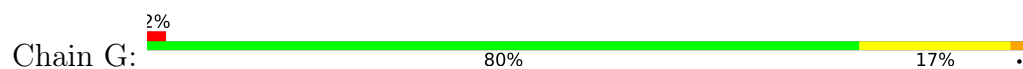
- Molecule 1: Tumor necrosis factor



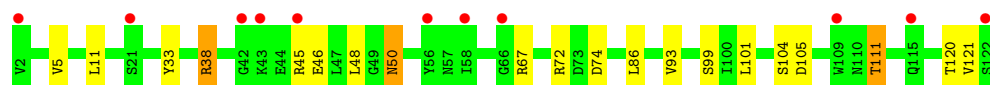
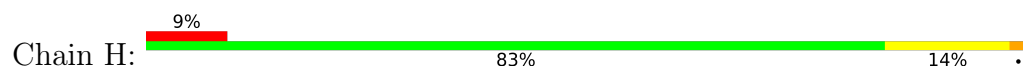
- Molecule 1: Tumor necrosis factor



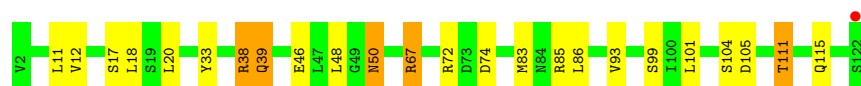
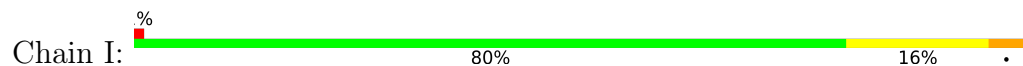
- Molecule 2: VHH1



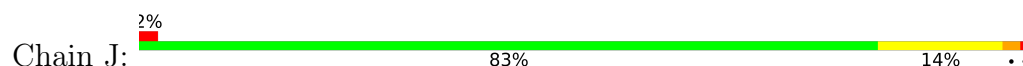
- Molecule 2: VHH1

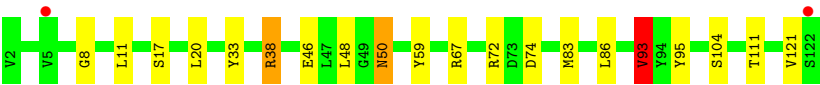


- Molecule 2: VHH1

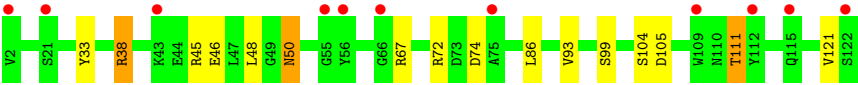
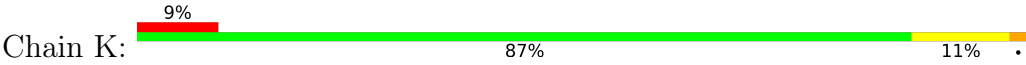


- Molecule 2: VHH1

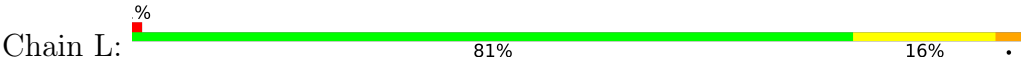




● Molecule 2: VHH1



● Molecule 2: VHH1



4 Data and refinement statistics

Property	Value	Source
Space group	P 21 21 21	Depositor
Cell constants a, b, c, α , β , γ	110.33Å 117.41Å 141.89Å 90.00° 90.00° 90.00°	Depositor
Resolution (Å)	48.68 – 2.15 48.68 – 2.15	Depositor EDS
% Data completeness (in resolution range)	99.9 (48.68-2.15) 99.8 (48.68-2.15)	Depositor EDS
R_{merge}	0.13	Depositor
R_{sym}	(Not available)	Depositor
$\langle I/\sigma(I) \rangle$ ¹	2.05 (at 2.16Å)	Xtrriage
Refinement program	BUSTER 2.10.1	Depositor
R, R_{free}	0.207 , 0.238 0.234 , 0.263	Depositor DCC
R_{free} test set	5026 reflections (5.00%)	wwPDB-VP
Wilson B-factor (Å ²)	31.8	Xtrriage
Anisotropy	0.668	Xtrriage
Bulk solvent k_{sol} (e/Å ³), B_{sol} (Å ²)	0.35 , 59.0	EDS
L-test for twinning ²	$\langle L \rangle = 0.50$, $\langle L^2 \rangle = 0.34$	Xtrriage
Estimated twinning fraction	No twinning to report.	Xtrriage
F_o, F_c correlation	0.95	EDS
Total number of atoms	13256	wwPDB-VP
Average B, all atoms (Å ²)	44.0	wwPDB-VP

Xtrriage's analysis on translational NCS is as follows: *The analyses of the Patterson function reveals a significant off-origin peak that is 49.23 % 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 7.6892e-05. The detected translational NCS is most likely also responsible for the elevated intensity ratio.*

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	0.71	0/1165	1.13	1/1590 (0.1%)
1	B	0.72	0/1162	1.15	2/1585 (0.1%)
1	C	0.72	0/1179	1.15	3/1606 (0.2%)
1	D	0.71	0/1169	1.12	1/1595 (0.1%)
1	E	0.75	0/1145	1.12	0/1560
1	F	0.70	0/1179	1.17	3/1606 (0.2%)
2	G	0.68	0/966	1.12	5/1309 (0.4%)
2	H	0.66	0/966	1.09	4/1309 (0.3%)
2	I	0.70	0/966	1.13	5/1309 (0.4%)
2	J	0.67	0/966	1.14	6/1309 (0.5%)
2	K	0.68	0/966	1.10	4/1309 (0.3%)
2	L	0.69	0/966	1.12	3/1309 (0.2%)
All	All	0.70	0/12795	1.13	37/17396 (0.2%)

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	E	0	2

There are no bond length outliers.

The worst 5 of 37 bond angle outliers are listed below:

Mol	Chain	Res	Type	Atoms	Z	Observed(°)	Ideal(°)
2	G	50	ASN	CA-CB-CG	8.00	120.60	112.60
2	J	50	ASN	CA-CB-CG	8.00	120.60	112.60
2	I	50	ASN	CA-CB-CG	7.88	120.48	112.60
2	L	50	ASN	CA-CB-CG	7.80	120.40	112.60
2	K	50	ASN	CA-CB-CG	7.53	120.13	112.60

There are no chirality outliers.

All (2) planarity outliers are listed below:

Mol	Chain	Res	Type	Group
1	E	105	THR	Mainchain,Peptide

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	1139	0	1118	20	0
1	B	1136	0	1121	30	0
1	C	1153	0	1144	24	0
1	D	1143	0	1122	24	0
1	E	1121	0	1105	24	0
1	F	1153	0	1144	25	0
2	G	944	0	908	10	0
2	H	944	0	908	8	0
2	I	944	0	908	11	0
2	J	944	0	908	8	0
2	K	944	0	908	6	0
2	L	944	0	908	10	0
3	A	52	0	0	0	0
3	B	51	0	0	2	0
3	C	55	0	0	0	0
3	D	56	0	0	2	0
3	E	37	0	0	1	0
3	F	60	0	0	0	0
3	G	78	0	0	0	0
3	H	59	0	0	0	0
3	I	79	0	0	1	0
3	J	95	0	0	0	0
3	K	48	0	0	0	0
3	L	77	0	0	0	0
All	All	13256	0	12202	165	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 165 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:28:TRP:H	1:A:46:ASN:HD21	1.11	0.96
1:D:28:TRP:H	1:D:46:ASN:HD21	1.14	0.95
1:C:28:TRP:H	1:C:46:ASN:HD21	1.20	0.89
2:I:12:VAL:HG11	2:I:18:LEU:HD13	1.58	0.84
1:F:28:TRP:H	1:F:46:ASN:HD21	1.26	0.83

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	146/157 (93%)	142 (97%)	3 (2%)	1 (1%)	18	13
1	B	146/157 (93%)	138 (94%)	6 (4%)	2 (1%)	9	4
1	C	146/157 (93%)	142 (97%)	4 (3%)	0	100	100
1	D	146/157 (93%)	143 (98%)	3 (2%)	0	100	100
1	E	142/157 (90%)	132 (93%)	8 (6%)	2 (1%)	9	4
1	F	146/157 (93%)	139 (95%)	7 (5%)	0	100	100
2	G	119/121 (98%)	117 (98%)	2 (2%)	0	100	100
2	H	119/121 (98%)	118 (99%)	1 (1%)	0	100	100
2	I	119/121 (98%)	118 (99%)	1 (1%)	0	100	100
2	J	119/121 (98%)	118 (99%)	1 (1%)	0	100	100
2	K	119/121 (98%)	118 (99%)	1 (1%)	0	100	100
2	L	119/121 (98%)	118 (99%)	1 (1%)	0	100	100
All	All	1586/1668 (95%)	1543 (97%)	38 (2%)	5 (0%)	36	34

All (5) Ramachandran outliers are listed below:

Mol	Chain	Res	Type
1	A	107	GLU
1	B	104	GLU
1	E	105	THR
1	E	104	GLU
1	B	103	ARG

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	120/133 (90%)	104 (87%)	16 (13%)	4	1
1	B	119/133 (90%)	105 (88%)	14 (12%)	5	2
1	C	123/133 (92%)	104 (85%)	19 (15%)	2	1
1	D	121/133 (91%)	105 (87%)	16 (13%)	4	1
1	E	117/133 (88%)	100 (86%)	17 (14%)	3	1
1	F	123/133 (92%)	104 (85%)	19 (15%)	2	1
2	G	100/100 (100%)	92 (92%)	8 (8%)	11	7
2	H	100/100 (100%)	92 (92%)	8 (8%)	11	7
2	I	100/100 (100%)	90 (90%)	10 (10%)	7	3
2	J	100/100 (100%)	92 (92%)	8 (8%)	11	7
2	K	100/100 (100%)	93 (93%)	7 (7%)	14	9
2	L	100/100 (100%)	89 (89%)	11 (11%)	6	3
All	All	1323/1398 (95%)	1170 (88%)	153 (12%)	5	2

5 of 153 residues with a non-rotameric sidechain are listed below:

Mol	Chain	Res	Type
2	H	93	VAL
2	L	17	SER
2	I	38	ARG
2	J	50	ASN
2	L	93	VAL

Sometimes sidechains can be flipped to improve hydrogen bonding and reduce clashes. 5 of 49 such sidechains are listed below:

Mol	Chain	Res	Type
1	F	21	GLN
2	G	82	GLN
1	F	30	ASN
1	F	46	ASN
2	G	118	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	148/157 (94%)	0.63	14 (9%) 14 15	27, 41, 82, 97	0
1	B	148/157 (94%)	0.94	26 (17%) 4 4	26, 46, 86, 116	0
1	C	148/157 (94%)	0.79	24 (16%) 4 5	24, 42, 87, 108	0
1	D	148/157 (94%)	0.68	17 (11%) 9 10	25, 41, 84, 111	0
1	E	146/157 (92%)	1.08	35 (23%) 2 2	21, 46, 81, 105	0
1	F	148/157 (94%)	0.60	15 (10%) 12 14	24, 38, 75, 91	0
2	G	121/121 (100%)	0.22	2 (1%) 69 73	26, 35, 55, 75	0
2	H	121/121 (100%)	0.72	11 (9%) 15 16	30, 46, 67, 88	0
2	I	121/121 (100%)	0.22	1 (0%) 82 84	20, 34, 51, 83	0
2	J	121/121 (100%)	0.20	2 (1%) 69 73	24, 33, 55, 71	0
2	K	121/121 (100%)	0.67	11 (9%) 15 16	30, 44, 69, 83	0
2	L	121/121 (100%)	0.27	1 (0%) 82 84	26, 38, 55, 87	0
All	All	1612/1668 (96%)	0.60	159 (9%) 13 14	20, 40, 77, 116	0

The worst 5 of 159 RSRZ outliers are listed below:

Mol	Chain	Res	Type	RSRZ
1	F	31	ARG	6.6
1	D	106	PRO	6.2
2	L	122	SER	6.1
1	E	106	PRO	5.9
2	I	122	SER	5.8

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.