



Full wwPDB X-ray Structure Validation Report ⓘ

Nov 3, 2021 – 10:02 AM EDT

PDB ID : 7N4L
Title : Crystal structure of SARS-CoV-2 receptor binding domain in complex with neutralizing human antibody WRAIR-2125.
Authors : Sankhala, R.S.; Joyce, M.G.
Deposited on : 2021-06-04
Resolution : 3.60 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 following versions of software and data (see [references ⓘ](#)) were used in the production of this report:

MolProbity	:	4.02b-467
Xtriage (Phenix)	:	1.13
EDS	:	2.23.2
Percentile statistics	:	20191225.v01 (using entries in the PDB archive December 25th 2019)
Refmac	:	5.8.0158
CCP4	:	7.0.044 (Gargrove)
Ideal geometry (proteins)	:	Engh & Huber (2001)
Ideal geometry (DNA, RNA)	:	Parkinson et al. (1996)
Validation Pipeline (wwPDB-VP)	:	2.23.2

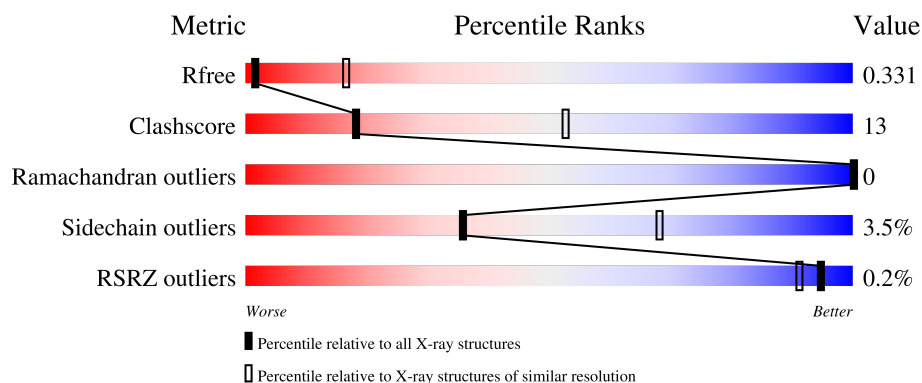
1 Overall quality at a glance

The following experimental techniques were used to determine the structure:

X-RAY DIFFRACTION




The reported resolution of this entry is 3.60 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}	130704	1257 (3.70-3.50)
Clashscore	141614	1353 (3.70-3.50)
Ramachandran outliers	138981	1307 (3.70-3.50)
Sidechain outliers	138945	1307 (3.70-3.50)
RSRZ outliers	127900	1161 (3.70-3.50)

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	205	 67% 29% ..
2	H	232	 57% 37% . .
3	L	214	 73% 24% ..

2 Entry composition

There are 3 unique types of molecules in this entry. The entry contains 4876 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 Spike protein S1.

Mol	Chain	Residues	Atoms					ZeroOcc	AltConf	Trace
1	A	200	Total	C	N	O	S	0	0	0
			1579	1010	265	296	8			

There are 8 discrepancies between the modelled and reference sequences:

Chain	Residue	Modelled	Actual	Comment	Reference
A	528	GLY	-	expression tag	UNP P0DTC2
A	529	SER	-	expression tag	UNP P0DTC2
A	530	HIS	-	expression tag	UNP P0DTC2
A	531	HIS	-	expression tag	UNP P0DTC2
A	532	HIS	-	expression tag	UNP P0DTC2
A	533	HIS	-	expression tag	UNP P0DTC2
A	534	HIS	-	expression tag	UNP P0DTC2
A	535	HIS	-	expression tag	UNP P0DTC2

- Molecule 2 is a protein called WRAIR-2125 antibody Fab heavy chain.

Mol	Chain	Residues	Atoms					ZeroOcc	AltConf	Trace
2	H	223	Total	C	N	O	S	0	0	0
			1671	1054	280	330	7			

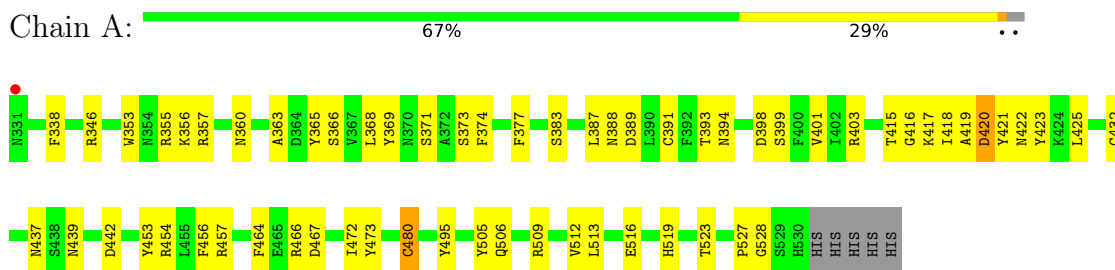
- Molecule 3 is a protein called WRAIR-2125 antibody Fab light chain.

Mol	Chain	Residues	Atoms					ZeroOcc	AltConf	Trace
3	L	211	Total	C	N	O	S	0	0	0
			1626	1016	273	332	5			

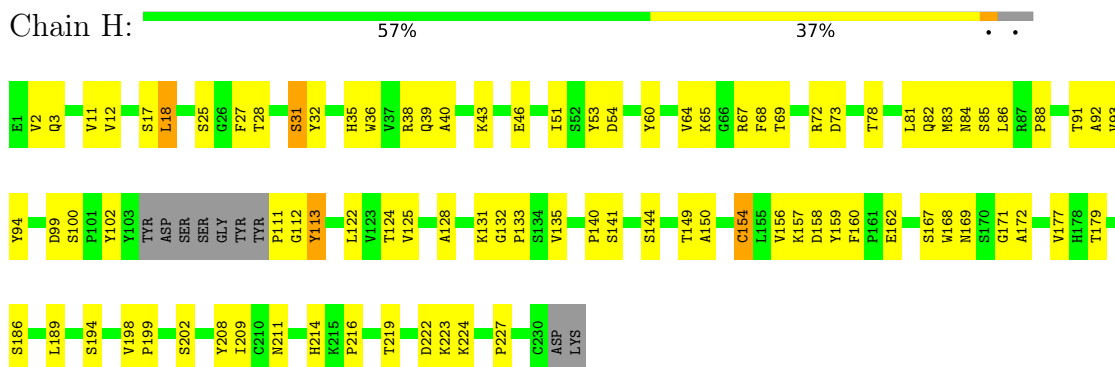
3 Residue-property plots

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.

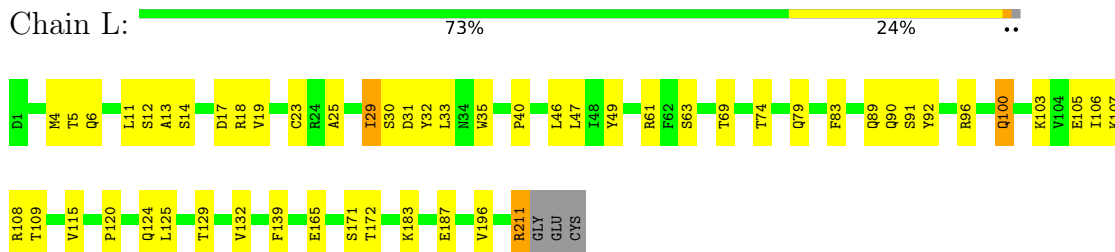
- Molecule 1: Spike protein S1



- Molecule 2: WRAIR-2125 antibody Fab heavy chain



- Molecule 3: WRAIR-2125 antibody Fab light chain



4 Data and refinement statistics

Property	Value	Source
Space group	P 61	Depositor
Cell constants a, b, c, α , β , γ	188.87Å 188.87Å 65.17Å 90.00° 90.00° 120.00°	Depositor
Resolution (Å)	19.98 – 3.60 163.57 – 3.25	Depositor EDS
% Data completeness (in resolution range)	78.4 (19.98-3.60) 60.9 (163.57-3.25)	Depositor EDS
R_{merge}	(Not available)	Depositor
R_{sym}	(Not available)	Depositor
$\langle I/\sigma(I) \rangle$ ¹	3.62 (at 3.26Å)	Xtriage
Refinement program	PHENIX 1.11.1_2575	Depositor
R, R_{free}	0.262 , 0.329 0.264 , 0.331	Depositor DCC
R_{free} test set	654 reflections (5.06%)	wwPDB-VP
Wilson B-factor (Å ²)	42.9	Xtriage
Anisotropy	0.669	Xtriage
Bulk solvent k_{sol} (e/Å ³), B_{sol} (Å ²)	0.33 , 26.1	EDS
L-test for twinning ²	$\langle L \rangle = 0.41$, $\langle L^2 \rangle = 0.24$	Xtriage
Estimated twinning fraction	0.069 for h,-h-k,-l	Xtriage
F_o, F_c correlation	0.80	EDS
Total number of atoms	4876	wwPDB-VP
Average B, all atoms (Å ²)	41.0	wwPDB-VP

Xtriage's analysis on translational NCS is as follows: *The largest off-origin peak in the Patterson function is 5.00% 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	0.30	0/1624	0.54	0/2211
2	H	0.30	0/1713	0.55	0/2330
3	L	0.28	0/1660	0.57	0/2256
All	All	0.29	0/4997	0.55	0/6797

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
2	H	0	2
3	L	0	1
All	All	0	3

There are no bond length outliers.

There are no bond angle outliers.

There are no chirality outliers.

All (3) planarity outliers are listed below:

Mol	Chain	Res	Type	Group
2	H	100	SER	Peptide
2	H	177	VAL	Peptide
3	L	29	ILE	Peptide

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	1579	0	1494	38	0
2	H	1671	0	1627	59	0
3	L	1626	0	1584	38	0
All	All	4876	0	4705	128	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 13.

All (128) 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:422:ASN:HD22	1:A:454:ARG:H	1.20	0.87
1:A:388:ASN:HB2	1:A:527:PRO:HD2	1.57	0.85
1:A:360:ASN:H	1:A:523:THR:HG22	1.41	0.85
2:H:88:PRO:HA	2:H:125:VAL:HG21	1.62	0.80
3:L:106:ILE:HD11	3:L:171:SER:HB3	1.64	0.79
1:A:472:ILE:HD13	1:A:480:CYS:HB3	1.68	0.76
3:L:83:PHE:HZ	3:L:165:GLU:HB3	1.50	0.76
3:L:103:LYS:NZ	3:L:165:GLU:OE1	2.19	0.74
2:H:82:GLN:OE1	2:H:84:ASN:ND2	2.18	0.73
3:L:12:SER:HA	3:L:105:GLU:HB2	1.74	0.70
1:A:338:PHE:HE1	1:A:363:ALA:HB1	1.56	0.69
3:L:89:GLN:HE21	3:L:96:ARG:HB3	1.57	0.69
3:L:83:PHE:CZ	3:L:165:GLU:HB3	2.27	0.68
1:A:353:TRP:O	1:A:466:ARG:NH1	2.27	0.67
3:L:106:ILE:CD1	3:L:171:SER:HB3	2.24	0.67
2:H:102:TYR:CE1	3:L:49:TYR:HB2	2.30	0.66
2:H:209:ILE:HD12	2:H:224:LYS:HG3	1.79	0.65
1:A:422:ASN:ND2	1:A:454:ARG:H	1.94	0.64
2:H:53:TYR:O	2:H:72:ARG:NH2	2.31	0.63
2:H:141:SER:OG	2:H:144:SER:OG	2.16	0.62
3:L:120:PRO:HD3	3:L:132:VAL:HG22	1.81	0.61
2:H:112:GLY:H	3:L:91:SER:HB3	1.64	0.61
3:L:14:SER:HA	3:L:106:ILE:HA	1.83	0.60
1:A:401:VAL:HG22	1:A:509:ARG:HA	1.83	0.59
2:H:209:ILE:HD11	2:H:222:ASP:HB3	1.86	0.58
1:A:398:ASP:HB2	1:A:512:VAL:HB	1.86	0.58
1:A:353:TRP:HZ3	1:A:355:ARG:HD3	1.69	0.58
1:A:403:ARG:HH11	1:A:505:TYR:HE1	1.51	0.57
2:H:64:VAL:HB	2:H:68:PHE:HB2	1.84	0.57
1:A:419:ALA:HA	1:A:423:TYR:O	2.05	0.56
2:H:93:VAL:HG12	2:H:122:LEU:HB2	1.87	0.56

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Atom-1	Atom-2	Interatomic distance (Å)	Clash overlap (Å)
3:L:115:VAL:HG11	3:L:196:VAL:HG21	1.87	0.56
3:L:107:LYS:HD2	3:L:109:THR:O	2.05	0.56
2:H:135:VAL:HG23	2:H:223:LYS:HG3	1.88	0.55
2:H:2:VAL:HG22	2:H:27:PHE:HB3	1.89	0.55
2:H:83:MET:HB3	2:H:86:LEU:HD21	1.88	0.55
3:L:90:GLN:OE1	3:L:90:GLN:N	2.36	0.55
1:A:338:PHE:CE1	1:A:363:ALA:HB1	2.39	0.55
2:H:40:ALA:HB3	2:H:43:LYS:HB2	1.88	0.55
1:A:425:LEU:HD21	1:A:512:VAL:HG11	1.89	0.54
2:H:67:ARG:HG3	2:H:85:SER:HB2	1.88	0.54
2:H:73:ASP:HB3	2:H:78:THR:HG23	1.90	0.54
2:H:83:MET:CB	2:H:86:LEU:HD21	2.39	0.53
2:H:135:VAL:HG12	2:H:156:VAL:HG13	1.91	0.53
3:L:5:THR:HA	3:L:100:GLN:OE1	2.09	0.53
2:H:102:TYR:OH	3:L:32:TYR:HA	2.10	0.52
2:H:102:TYR:HD2	2:H:111:PRO:HA	1.74	0.52
1:A:418:ILE:HA	1:A:422:ASN:OD1	2.09	0.52
1:A:366:SER:HA	1:A:369:TYR:CZ	2.46	0.51
2:H:102:TYR:HE1	3:L:49:TYR:HB2	1.77	0.50
2:H:113:TYR:HE1	3:L:46:LEU:CD2	2.25	0.50
3:L:187:GLU:HG3	3:L:211:ARG:NH2	2.27	0.50
2:H:149:THR:OG1	2:H:150:ALA:N	2.44	0.49
1:A:357:ARG:NH2	1:A:394:ASN:HD22	2.10	0.49
1:A:457:ARG:NH1	1:A:467:ASP:OD2	2.45	0.49
1:A:437:ASN:OD1	1:A:439:ASN:N	2.45	0.49
2:H:140:PRO:HD2	2:H:227:PRO:HA	1.94	0.49
2:H:11:VAL:HA	2:H:124:THR:O	2.13	0.48
2:H:169:ASN:HB3	2:H:172:ALA:HB3	1.94	0.48
2:H:17:SER:HB2	2:H:84:ASN:HA	1.95	0.48
2:H:12:VAL:HG11	2:H:18:LEU:HD22	1.94	0.48
2:H:113:TYR:HE1	3:L:46:LEU:HD22	1.78	0.48
3:L:25:ALA:HB3	3:L:69:THR:HA	1.96	0.48
3:L:40:PRO:HB2	3:L:165:GLU:OE2	2.14	0.48
3:L:61:ARG:NH1	3:L:79:GLN:HG3	2.30	0.47
1:A:371:SER:OG	1:A:373:SER:OG	2.32	0.47
1:A:415:THR:HG23	1:A:420:ASP:OD2	2.15	0.46
1:A:421:TYR:CD1	1:A:457:ARG:HB3	2.50	0.46
1:A:432:CYS:HB2	1:A:513:LEU:HB2	1.96	0.46
2:H:131:LYS:NZ	2:H:132:GLY:O	2.48	0.46
2:H:102:TYR:CD2	2:H:111:PRO:HA	2.51	0.46
3:L:30:SER:OG	3:L:31:ASP:N	2.48	0.46

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Atom-1	Atom-2	Interatomic distance (Å)	Clash overlap (Å)
2:H:93:VAL:HA	2:H:122:LEU:HA	1.97	0.46
3:L:18:ARG:HE	3:L:18:ARG:HB2	1.59	0.46
1:A:368:LEU:HA	1:A:374:PHE:HE2	1.79	0.46
2:H:113:TYR:CG	2:H:113:TYR:O	2.68	0.45
3:L:23:CYS:HB2	3:L:35:TRP:CH2	2.51	0.45
3:L:11:LEU:HD11	3:L:13:ALA:HB2	1.98	0.45
1:A:403:ARG:HA	1:A:506:GLN:O	2.17	0.45
1:A:394:ASN:OD1	1:A:516:GLU:HG2	2.17	0.45
2:H:3:GLN:HB2	2:H:25:SER:HB3	1.98	0.45
3:L:17:ASP:HB3	3:L:19:VAL:HG13	1.98	0.45
2:H:69:THR:HG23	2:H:82:GLN:HB3	1.99	0.44
2:H:150:ALA:HB3	2:H:198:VAL:HG23	1.98	0.44
2:H:214:HIS:CE1	2:H:216:PRO:HG2	2.52	0.44
1:A:456:PHE:HB3	1:A:473:TYR:CG	2.53	0.44
3:L:63:SER:O	3:L:74:THR:N	2.30	0.44
2:H:99:ASP:OD1	2:H:112:GLY:HA2	2.17	0.44
1:A:417:LYS:O	1:A:421:TYR:HB2	2.18	0.43
1:A:519:HIS:O	1:A:519:HIS:ND1	2.52	0.43
1:A:442:ASP:OD1	1:A:509:ARG:NH2	2.31	0.43
2:H:159:TYR:OH	2:H:162:GLU:OE2	2.29	0.43
3:L:125:LEU:O	3:L:183:LYS:HD2	2.18	0.43
2:H:128:ALA:HB3	2:H:160:PHE:CE2	2.53	0.43
3:L:124:GLN:HG2	3:L:129:THR:O	2.18	0.43
3:L:32:TYR:HB2	3:L:92:TYR:HB2	2.00	0.43
1:A:365:TYR:HD1	1:A:388:ASN:HB3	1.84	0.42
1:A:425:LEU:HD23	1:A:464:PHE:HE1	1.85	0.42
3:L:6:GLN:O	3:L:100:GLN:NE2	2.53	0.42
2:H:60:TYR:HB2	2:H:65:LYS:CG	2.49	0.42
2:H:154:CYS:HB2	2:H:168:TRP:CZ2	2.54	0.42
2:H:167:SER:HB3	2:H:171:GLY:HA2	2.02	0.42
3:L:139:PHE:N	3:L:172:THR:HB	2.35	0.42
1:A:383:SER:O	1:A:387:LEU:HB2	2.20	0.42
2:H:39:GLN:O	2:H:92:ALA:HB1	2.20	0.42
2:H:158:ASP:HB3	2:H:189:LEU:HD13	2.02	0.42
2:H:167:SER:N	2:H:211:ASN:O	2.46	0.42
1:A:360:ASN:H	1:A:523:THR:CG2	2.22	0.41
1:A:393:THR:O	1:A:523:THR:HB	2.19	0.41
1:A:416:GLY:O	1:A:420:ASP:HB2	2.20	0.41
2:H:12:VAL:HG11	2:H:86:LEU:HD12	2.01	0.41
2:H:28:THR:HG22	2:H:31:SER:H	1.85	0.41
2:H:199:PRO:HB2	2:H:202:SER:HB3	2.02	0.41

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Atom-1	Atom-2	Interatomic distance (Å)	Clash overlap (Å)
2:H:133:PRO:HD2	2:H:219:THR:HG21	2.02	0.41
2:H:209:ILE:HG13	2:H:223:LYS:C	2.41	0.41
2:H:35:HIS:NE2	2:H:99:ASP:OD2	2.44	0.41
3:L:46:LEU:HG	3:L:47:LEU:N	2.36	0.41
2:H:38:ARG:NH2	2:H:46:GLU:OE2	2.53	0.41
2:H:91:THR:HG23	2:H:124:THR:HA	2.02	0.41
3:L:4:MET:HE1	3:L:25:ALA:HB2	2.03	0.41
2:H:38:ARG:HD3	2:H:94:TYR:CE2	2.56	0.41
3:L:29:ILE:HD12	3:L:33:LEU:HD11	2.02	0.41
2:H:51:ILE:HD13	2:H:72:ARG:HG2	2.02	0.41
2:H:179:THR:HG22	2:H:194:SER:OG	2.21	0.40
1:A:453:TYR:HD1	1:A:495:TYR:CE2	2.39	0.40
2:H:112:GLY:N	3:L:91:SER:HB3	2.33	0.40
1:A:389:ASP:HA	1:A:528:GLY:O	2.22	0.40
2:H:36:TRP:CD1	2:H:81:LEU:HB2	2.56	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	198/205 (97%)	179 (90%)	19 (10%)	0	100	100
2	H	219/232 (94%)	200 (91%)	19 (9%)	0	100	100
3	L	209/214 (98%)	189 (90%)	20 (10%)	0	100	100
All	All	626/651 (96%)	568 (91%)	58 (9%)	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	172/177 (97%)	165 (96%)	7 (4%)	30	64
2	H	189/197 (96%)	180 (95%)	9 (5%)	25	60
3	L	187/189 (99%)	184 (98%)	3 (2%)	62	83
All	All	548/563 (97%)	529 (96%)	19 (4%)	36	68

All (19) residues with a non-rotameric sidechain are listed below:

Mol	Chain	Res	Type
1	A	346	ARG
1	A	356	LYS
1	A	377	PHE
1	A	391	CYS
1	A	399	SER
1	A	420	ASP
1	A	480	CYS
2	H	18	LEU
2	H	31	SER
2	H	32	TYR
2	H	54	ASP
2	H	113	TYR
2	H	154	CYS
2	H	157	LYS
2	H	186	SER
2	H	208	TYR
3	L	100	GLN
3	L	108	ARG
3	L	211	ARG

Sometimes sidechains can be flipped to improve hydrogen bonding and reduce clashes. All (1) such sidechains are listed below:

Mol	Chain	Res	Type
3	L	138	ASN

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 monosaccharides 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	200/205 (97%)	-0.10	1 (0%) 91 83	14, 30, 64, 88	0
2	H	223/232 (96%)	-0.35	0 100 100	19, 41, 76, 119	0
3	L	211/214 (98%)	-0.21	0 100 100	25, 42, 62, 82	0
All	All	634/651 (97%)	-0.22	1 (0%) 95 91	14, 38, 70, 119	0

All (1) RSRZ outliers are listed below:

Mol	Chain	Res	Type	RSRZ
1	A	331	ASN	2.2

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 monosaccharides 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.