



# Full wwPDB X-ray Structure Validation Report ⓘ

Jan 16, 2021 – 03:52 PM EST

PDB ID : 7JX3  
Title : Mapping neutralizing and immunodominant sites on the SARS-CoV-2 spike receptor-binding domain by structure-guided high-resolution serology  
Authors : Snell, G.; Czudnochowski, N.; Rosen, L.E.; Nix, J.C.; Corti, D.; Veessler, D.; Park, Y.J.; Walls, A.C.; Tortorici, M.A.; Camerini, E.; Pinto, D.; Beltramello, M.  
Deposited on : 2020-08-26  
Resolution : 2.65 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](mailto: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:

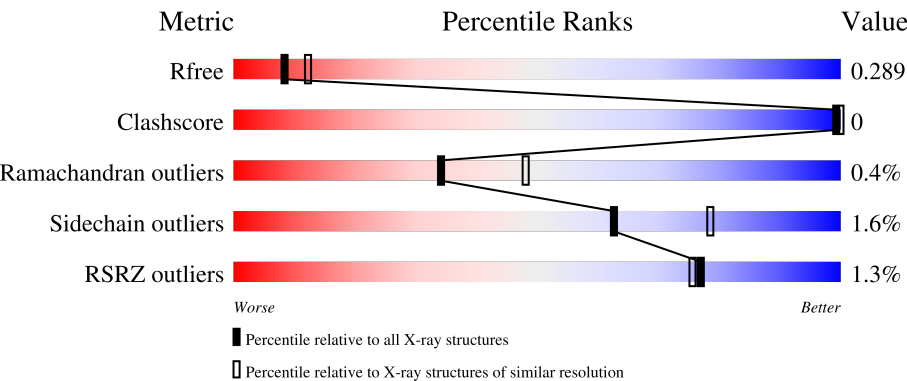
MolProbity	:	4.02b-467
Mogul	:	1.8.5 (274361), CSD as541be (2020)
Xtriage (Phenix)	:	1.13
EDS	:	2.16
Percentile statistics	:	20191225.v01 (using entries in the PDB archive December 25th 2019)
Refmac	:	5.8.0158
CCP4	:	7.0.044 (Gargrove)
Ideal geometry (proteins)	:	Engh & Huber (2001)
Ideal geometry (DNA, RNA)	:	Parkinson et al. (1996)
Validation Pipeline (wwPDB-VP)	:	2.16

# 1 Overall quality at a glance i

The following experimental techniques were used to determine the structure:  
*X-RAY DIFFRACTION*

The reported resolution of this entry is 2.65 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 <sub>free</sub>	130704	1332 (2.68-2.64)
Clashscore	141614	1374 (2.68-2.64)
Ramachandran outliers	138981	1349 (2.68-2.64)
Sidechain outliers	138945	1349 (2.68-2.64)
RSRZ outliers	127900	1318 (2.68-2.64)

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  $\geq 3$ , 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	B	214	<div><div></div><div>98%</div><div>.</div></div>
2	A	230	<div><div>2%</div><div>97%</div><div>..</div></div>
3	D	216	<div><div>%</div><div>95%</div><div>..</div></div>
4	C	229	<div><div>%</div><div>97%</div><div>..</div></div>
5	L	215	<div><div>%</div><div>97%</div><div>.</div></div>

Continued on next page...

Continued from previous page...

Mol	Chain	Length	Quality of chain
6	H	223	<div> <div></div> <div>99%</div> <div></div> </div>
7	R	204	<div> <div></div> <div>94%</div> <div></div> </div>

## 2 Entry composition

There are 9 unique types of molecules in this entry. The entry contains 11518 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 Light chain of Fab domain of monoclonal antibody S309.

Mol	Chain	Residues	Atoms					ZeroOcc	AltConf	Trace
1	B	213	Total	C	N	O	S	0	0	0
			1624	1011	277	332	4			

- Molecule 2 is a protein called Heavy chain of Fab domain of monoclonal antibody S309.

Mol	Chain	Residues	Atoms					ZeroOcc	AltConf	Trace
2	A	224	Total	C	N	O	S	0	0	0
			1687	1065	285	330	7			

- Molecule 3 is a protein called Light chain of Fab domain of monoclonal antibody S2H14.

Mol	Chain	Residues	Atoms					ZeroOcc	AltConf	Trace
3	D	213	Total	C	N	O	S	0	0	0
			1603	993	268	337	5			

- Molecule 4 is a protein called Heavy chain of Fab domain of monoclonal antibody S2H14.

Mol	Chain	Residues	Atoms					ZeroOcc	AltConf	Trace
4	C	227	Total	C	N	O	S	0	0	0
			1692	1068	279	339	6			

- Molecule 5 is a protein called Light chain of Fab domain of monoclonal antibody S304.

Mol	Chain	Residues	Atoms					ZeroOcc	AltConf	Trace
5	L	215	Total	C	N	O	S	0	0	0
			1643	1029	272	336	6			

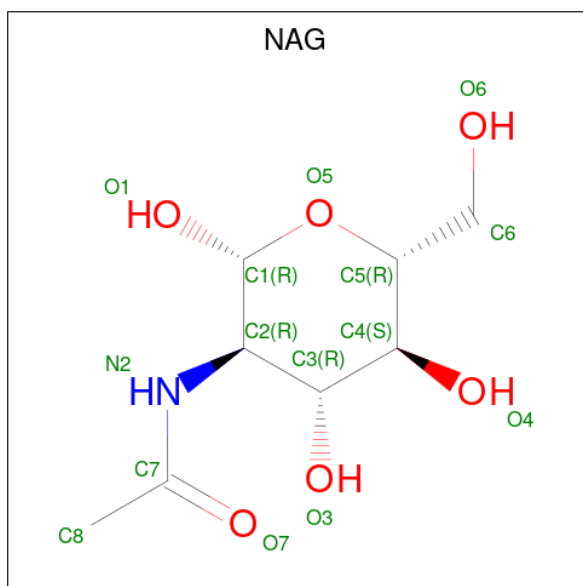
- Molecule 6 is a protein called Heavy chain of Fab domain of monoclonal antibody S304.

Mol	Chain	Residues	Atoms					ZeroOcc	AltConf	Trace
6	H	222	Total	C	N	O	S	0	0	0
			1661	1048	274	332	7			

- Molecule 7 is a protein called Spike protein S1.

Mol	Chain	Residues	Atoms					ZeroOcc	AltConf	Trace
7	R	198	Total	C	N	O	S	0	1	0
			1569	1007	262	292	8			

- Molecule 8 is 2-acetamido-2-deoxy-beta-D-glucopyranose (three-letter code: NAG) (formula:  $C_8H_{15}NO_6$ ).



Mol	Chain	Residues	Atoms				ZeroOcc	AltConf
8	R	1	Total	C	N	O	0	0
			14	8	1	5		

- Molecule 9 is water.

Mol	Chain	Residues	Atoms		ZeroOcc	AltConf
9	B	5	Total	O	0	0
			5	5		
9	A	3	Total	O	0	0
			3	3		
9	D	2	Total	O	0	0
			2	2		
9	C	5	Total	O	0	0
			5	5		
9	L	1	Total	O	0	0
			1	1		
9	H	2	Total	O	0	0
			2	2		

*Continued on next page...*

*Continued from previous page...*

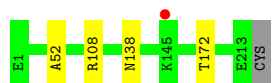
Mol	Chain	Residues	Atoms		ZeroOcc	AltConf
9	R	7	Total	O	0	0
			7	7		

### 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.

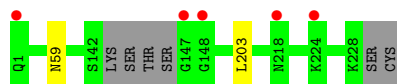
- Molecule 1: Light chain of Fab domain of monoclonal antibody S309

Chain B:  98%



- Molecule 2: Heavy chain of Fab domain of monoclonal antibody S309

Chain A:  97%



- Molecule 3: Light chain of Fab domain of monoclonal antibody S2H14

Chain D:  95%



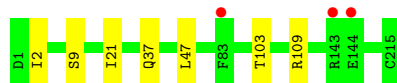
- Molecule 4: Heavy chain of Fab domain of monoclonal antibody S2H14

Chain C:  97%



- Molecule 5: Light chain of Fab domain of monoclonal antibody S304

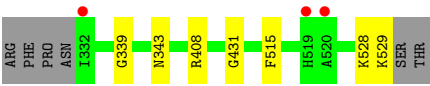
Chain L:  97%



- Molecule 6: Heavy chain of Fab domain of monoclonal antibody S304



● Molecule 7: Spike protein S1





## 4 Data and refinement statistics

Property	Value	Source
Space group	C 1 2 1	Depositor
Cell constants a, b, c, $\alpha$ , $\beta$ , $\gamma$	79.54Å 127.78Å 192.28Å 90.00° 96.66° 90.00°	Depositor
Resolution (Å)	47.50 – 2.65 47.75 – 2.65	Depositor EDS
% Data completeness (in resolution range)	98.5 (47.50-2.65) 98.5 (47.75-2.65)	Depositor EDS
$R_{merge}$	0.20	Depositor
$R_{sym}$	(Not available)	Depositor
$\langle I/\sigma(I) \rangle$ <sup>1</sup>	1.65 (at 2.65Å)	Xtriage
Refinement program	REFMAC 5.8.0258	Depositor
R, $R_{free}$	0.258 , 0.288 0.256 , 0.289	Depositor DCC
$R_{free}$ test set	2586 reflections (4.74%)	wwPDB-VP
Wilson B-factor (Å <sup>2</sup> )	58.5	Xtriage
Anisotropy	0.271	Xtriage
Bulk solvent $k_{sol}$ (e/Å <sup>3</sup> ), $B_{sol}$ (Å <sup>2</sup> )	0.25 , 19.1	EDS
L-test for twinning <sup>2</sup>	$\langle  L  \rangle = 0.49$ , $\langle L^2 \rangle = 0.32$	Xtriage
Estimated twinning fraction	No twinning to report.	Xtriage
$F_o, F_c$ correlation	0.92	EDS
Total number of atoms	11518	wwPDB-VP
Average B, all atoms (Å <sup>2</sup> )	72.0	wwPDB-VP

Xtriage's analysis on translational NCS is as follows: *The largest off-origin peak in the Patterson function is 3.73% of the height of the origin peak. No significant pseudotranslation is detected.*

<sup>1</sup>Intensities estimated from amplitudes.

<sup>2</sup>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

Bond lengths and bond angles in the following residue types are not validated in this section: NAG

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	B	0.69	0/1657	0.75	0/2250
2	A	0.68	0/1729	0.74	0/2355
3	D	0.69	0/1641	0.74	0/2240
4	C	0.68	0/1734	0.76	0/2362
5	L	0.68	0/1679	0.74	0/2280
6	H	0.68	0/1703	0.74	0/2318
7	R	0.67	0/1613	0.75	0/2194
All	All	0.68	0/11756	0.75	0/15999

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
4	C	0	1

There are no bond length outliers.

There are no bond angle outliers.

There are no chirality outliers.

All (1) planarity outliers are listed below:

Mol	Chain	Res	Type	Group
4	C	32	ALA	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	B	1624	0	1582	0	0
2	A	1687	0	1642	0	0
3	D	1603	0	1534	0	0
4	C	1692	0	1653	0	0
5	L	1643	0	1595	2	0
6	H	1661	0	1601	0	0
7	R	1569	0	1496	2	0
8	R	14	0	13	0	0
9	A	3	0	0	0	0
9	B	5	0	0	0	0
9	C	5	0	0	0	0
9	D	2	0	0	0	0
9	H	2	0	0	0	0
9	L	1	0	0	0	0
9	R	7	0	0	0	0
All	All	11518	0	11116	4	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 0.

All (4) 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)
7:R:339:GLY:O	7:R:343:ASN:HB2	1.95	0.66
7:R:431:GLY:HA2	7:R:515:PHE:CD2	2.52	0.45
5:L:21:ILE:HD12	5:L:103:THR:HG21	2.03	0.41
5:L:37:GLN:HB2	5:L:47:LEU:HD11	2.03	0.41

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	B	211/214 (99%)	201 (95%)	8 (4%)	2 (1%)	17	26
2	A	220/230 (96%)	209 (95%)	11 (5%)	0	100	100
3	D	211/216 (98%)	198 (94%)	10 (5%)	3 (1%)	11	16
4	C	225/229 (98%)	216 (96%)	9 (4%)	0	100	100
5	L	213/215 (99%)	201 (94%)	11 (5%)	1 (0%)	29	43
6	H	220/223 (99%)	212 (96%)	8 (4%)	0	100	100
7	R	196/204 (96%)	189 (96%)	7 (4%)	0	100	100
All	All	1496/1531 (98%)	1426 (95%)	64 (4%)	6 (0%)	34	48

All (6) Ramachandran outliers are listed below:

Mol	Chain	Res	Type
3	D	111	GLY
3	D	155	ASP
1	B	52	ALA
1	B	138	ASN
3	D	86	GLU
5	L	2	ILE

### 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	B	184/185 (100%)	182 (99%)	2 (1%)	73	85

*Continued on next page...*

*Continued from previous page...*

Mol	Chain	Analysed	Rotameric	Outliers	Percentiles	
2	A	186/192 (97%)	184 (99%)	2 (1%)	73	85
3	D	186/189 (98%)	182 (98%)	4 (2%)	52	70
4	C	190/192 (99%)	185 (97%)	5 (3%)	46	64
5	L	188/188 (100%)	186 (99%)	2 (1%)	73	85
6	H	185/186 (100%)	183 (99%)	2 (1%)	73	85
7	R	171/177 (97%)	168 (98%)	3 (2%)	59	75
All	All	1290/1309 (98%)	1270 (98%)	20 (2%)	62	78

All (20) residues with a non-rotameric sidechain are listed below:

Mol	Chain	Res	Type
1	B	108	ARG
1	B	172	THR
2	A	59	ASN
2	A	203	LEU
3	D	70	SER
3	D	92	GLN
3	D	98	ASN
3	D	174	ASN
4	C	11	LEU
4	C	18	LEU
4	C	21	SER
4	C	30	SER
4	C	90	THR
5	L	9	SER
5	L	109	ARG
6	H	76	ASN
6	H	137	SER
7	R	408	ARG
7	R	528	LYS
7	R	529	LYS

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

Mol	Chain	Res	Type
2	A	218	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 ⓘ

There are no monosaccharides in this entry.

## 5.6 Ligand geometry ⓘ

1 ligand is modelled in this entry.

In the following table, the Counts columns list the number of bonds (or angles) for which Mogul statistics could be retrieved, the number of bonds (or angles) that are observed in the model and the number of bonds (or angles) that are defined in the Chemical Component Dictionary. The Link column lists molecule types, if any, to which the group is linked. 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  $|Z| > 2$  is considered an outlier worth inspection. RMSZ is the root-mean-square of all Z scores of the bond lengths (or angles).

Mol	Type	Chain	Res	Link	Bond lengths			Bond angles		
					Counts	RMSZ	$\# Z  > 2$	Counts	RMSZ	$\# Z  > 2$
8	NAG	R	601	7	14,14,15	1.61	2 (14%)	17,19,21	1.86	5 (29%)

In the following table, the Chirals column lists the number of chiral outliers, the number of chiral centers analysed, the number of these observed in the model and the number defined in the Chemical Component Dictionary. Similar counts are reported in the Torsion and Rings columns. '-' means no outliers of that kind were identified.

Mol	Type	Chain	Res	Link	Chirals	Torsions	Rings
8	NAG	R	601	7	-	0/6/23/26	0/1/1/1

All (2) bond length outliers are listed below:

Mol	Chain	Res	Type	Atoms	Z	Observed(Å)	Ideal(Å)
8	R	601	NAG	C1-C2	4.54	1.59	1.52
8	R	601	NAG	O5-C1	3.05	1.48	1.43

All (5) bond angle outliers are listed below:

Mol	Chain	Res	Type	Atoms	Z	Observed(°)	Ideal(°)
8	R	601	NAG	C1-O5-C5	4.39	118.14	112.19
8	R	601	NAG	O5-C1-C2	-3.24	106.18	111.29
8	R	601	NAG	C1-C2-N2	3.03	115.67	110.49
8	R	601	NAG	C4-C3-C2	3.00	115.42	111.02
8	R	601	NAG	O5-C5-C6	2.40	110.97	107.20

There are no chirality outliers.

There are no torsion outliers.

There are no ring outliers.

No monomer is involved in short contacts.

## 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 ⓘ

### 6.1 Protein, DNA and RNA chains ⓘ

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, 95<sup>th</sup> 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 <sup>2</sup> )	Q<0.9
1	B	213/214 (99%)	-0.03	1 (0%) 91 91	46, 63, 94, 116	0
2	A	224/230 (97%)	-0.01	5 (2%) 62 57	45, 73, 106, 119	0
3	D	213/216 (98%)	0.08	3 (1%) 75 73	57, 85, 115, 135	0
4	C	227/229 (99%)	0.04	3 (1%) 77 75	53, 72, 98, 158	0
5	L	215/215 (100%)	0.09	3 (1%) 75 73	40, 63, 85, 98	0
6	H	222/223 (99%)	0.02	2 (0%) 84 83	48, 77, 103, 126	0
7	R	198/204 (97%)	0.07	3 (1%) 73 71	42, 63, 103, 143	0
All	All	1512/1531 (98%)	0.04	20 (1%) 77 75	40, 71, 105, 158	0

All (20) RSRZ outliers are listed below:

Mol	Chain	Res	Type	RSRZ
7	R	332	ILE	3.8
2	A	1	GLN	3.3
3	D	193	ARG	3.2
7	R	519	HIS	3.1
5	L	143	ARG	3.0
2	A	224	LYS	3.0
4	C	90	THR	2.5
6	H	199	GLN	2.5
7	R	520	ALA	2.5
2	A	148	GLY	2.4
4	C	227	LYS	2.4
4	C	214	LYS	2.4
3	D	191	SER	2.3
5	L	144	GLU	2.3
2	A	147	GLY	2.2
3	D	1	ASN	2.1
2	A	218	ASN	2.1

*Continued on next page...*



*Continued from previous page...*

Mol	Chain	Res	Type	RSRZ
5	L	83	PHE	2.1
1	B	145	LYS	2.1
6	H	26	GLY	2.0

## 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](#)

In the following table, the Atoms column lists the number of modelled atoms in the group and the number defined in the chemical component dictionary. The B-factors column lists the minimum, median, 95<sup>th</sup> percentile and maximum values of B factors of atoms in the group. The column labelled 'Q< 0.9' lists the number of atoms with occupancy less than 0.9.

Mol	Type	Chain	Res	Atoms	RSCC	RSR	B-factors( $\text{\AA}^2$ )	Q<0.9
8	NAG	R	601	14/15	0.93	0.24	71,85,110,118	0

## 6.5 Other polymers [i](#)

There are no such residues in this entry.