



# Full wwPDB X-ray Structure Validation Report ⓘ

Sep 24, 2024 – 08:11 PM JST

PDB ID : 8WSH  
Title : Crystal structure of SARS-Cov-2 main protease, pH=4.0  
Authors : Zhou, X.L.; Jiang, H.H.; Zhang, J.; Li, J.  
Deposited on : 2023-10-17  
Resolution : 1.80 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 types of validation reports are described at

<http://www.wwpdb.org/validation/2017/FAQs#types>.

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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 : 3.0  
Percentile statistics : 20231227.v01 (using entries in the PDB archive December 27th 2023)  
CCP4 : 9.0.002 (Gargrove)  
Density-Fitness : 1.0.11  
Ideal geometry (proteins) : Engh & Huber (2001)  
Ideal geometry (DNA, RNA) : Parkinson et al. (1996)  
Validation Pipeline (wwPDB-VP) : 2.38.2

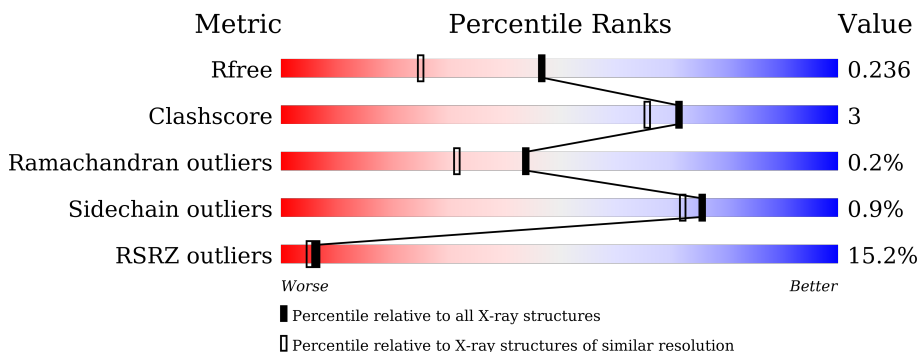
# 1 Overall quality at a glance

The following experimental techniques were used to determine the structure:

*X-RAY DIFFRACTION*

The reported resolution of this entry is 1.80 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))
$R_{free}$	164625	7108 (1.80-1.80)
Clashscore	180529	8162 (1.80-1.80)
Ramachandran outliers	177936	8077 (1.80-1.80)
Sidechain outliers	177891	8076 (1.80-1.80)
RSRZ outliers	164620	7108 (1.80-1.80)

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	A	298	 11% 94%
1	B	298	 19% 94% 6%

## 2 Entry composition

There are 2 unique types of molecules in this entry. The entry contains 4500 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 Replicase polyprotein 1ab.

Mol	Chain	Residues	Atoms					ZeroOcc	AltConf	Trace
			Total	C	N	O	S			
1	A	294	2190	1389	370	410	21	0	0	0
1	B	298	2150	1366	365	399	20	0	0	0

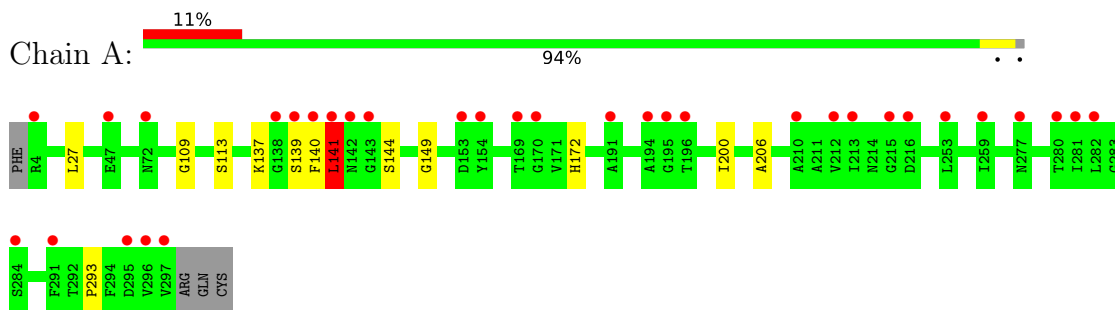
- Molecule 2 is water.

Mol	Chain	Residues	Atoms		ZeroOcc	AltConf
2	A	94	Total	O	0	0
			94	94		
2	B	66	Total	O	0	0
			66	66		

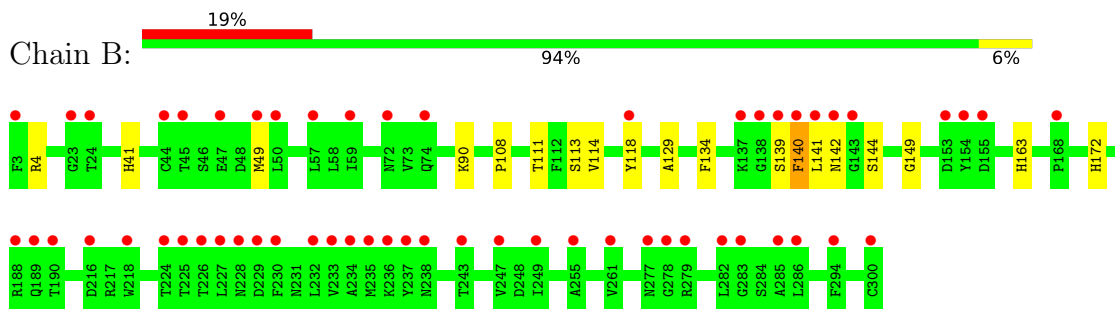
### 3 Residue-property plots [i](#)

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: Replicase polypeptide 1ab



- Molecule 1: Replicase polypeptide 1ab



## 4 Data and refinement statistics

Property	Value	Source
Space group	P 21 21 21	Depositor
Cell constants a, b, c, $\alpha$ , $\beta$ , $\gamma$	68.06Å 102.60Å 103.82Å 90.00° 90.00° 90.00°	Depositor
Resolution (Å)	51.31 – 1.80 51.31 – 1.80	Depositor EDS
% Data completeness (in resolution range)	97.8 (51.31-1.80) 97.8 (51.31-1.80)	Depositor EDS
$R_{merge}$	0.10	Depositor
$R_{sym}$	(Not available)	Depositor
$\langle I/\sigma(I) \rangle$ <sup>1</sup>	2.29 (at 1.81Å)	Xtrriage
Refinement program	PHENIX 1.12_2829	Depositor
R, $R_{free}$	0.213 , 0.236 0.213 , 0.236	Depositor DCC
$R_{free}$ test set	3441 reflections (5.08%)	wwPDB-VP
Wilson B-factor (Å <sup>2</sup> )	26.2	Xtrriage
Anisotropy	0.632	Xtrriage
Bulk solvent $k_{sol}$ (e/Å <sup>3</sup> ), $B_{sol}$ (Å <sup>2</sup> )	0.38 , 47.6	EDS
L-test for twinning <sup>2</sup>	$\langle  L  \rangle = 0.49$ , $\langle L^2 \rangle = 0.32$	Xtrriage
Estimated twinning fraction	0.015 for -h,l,k	Xtrriage
$F_o, F_c$ correlation	0.95	EDS
Total number of atoms	4500	wwPDB-VP
Average B, all atoms (Å <sup>2</sup> )	33.0	wwPDB-VP

Xtrriage's analysis on translational NCS is as follows: *The largest off-origin peak in the Patterson function is 3.91% 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 [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	0.38	0/2239	0.58	0/3055
1	B	0.37	0/2200	0.56	0/3011
All	All	0.37	0/4439	0.57	0/6066

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	B	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
1	B	140	PHE	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	2190	0	2074	10	0
1	B	2150	0	1973	19	0
2	A	94	0	0	0	0

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Mol	Chain	Non-H	H(model)	H(added)	Clashes	Symm-Clashes
2	B	66	0	0	0	0
All	All	4500	0	4047	27	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 3.

All (27) 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:B:141:LEU:H	1:B:142:ASN:HA	1.33	0.92
1:B:141:LEU:N	1:B:142:ASN:HA	2.02	0.73
1:B:141:LEU:HB2	1:B:144:SER:HB2	1.73	0.69
1:B:114:VAL:HG11	1:B:140:PHE:CZ	2.27	0.69
1:A:140:PHE:HD2	1:A:172:HIS:CG	2.14	0.65
1:B:114:VAL:HG11	1:B:140:PHE:HZ	1.63	0.61
1:A:141:LEU:H	1:A:141:LEU:HD23	1.66	0.60
1:B:118:TYR:HB2	1:B:141:LEU:HD21	1.82	0.60
1:B:141:LEU:H	1:B:142:ASN:CA	2.13	0.58
1:B:141:LEU:CB	1:B:144:SER:HB2	2.35	0.55
1:A:139:SER:OG	1:B:4:ARG:HB2	2.09	0.53
1:A:141:LEU:HG	1:A:144:SER:HB3	1.91	0.51
1:A:137:LYS:O	1:B:4:ARG:NE	2.35	0.49
1:A:140:PHE:HB2	1:A:172:HIS:NE2	2.29	0.48
1:B:140:PHE:HB3	1:B:163:HIS:CE1	2.50	0.47
1:B:41:HIS:HB2	1:B:49:MET:CE	2.46	0.47
1:A:206:ALA:HB2	1:A:293:PRO:HG3	1.98	0.46
1:B:140:PHE:HB2	1:B:172:HIS:CD2	2.51	0.45
1:A:140:PHE:CD2	1:A:172:HIS:CG	3.02	0.45
1:B:140:PHE:HB2	1:B:172:HIS:NE2	2.32	0.45
1:B:111:THR:HG22	1:B:129:ALA:HB2	1.99	0.45
1:B:113:SER:O	1:B:149:GLY:HA2	2.18	0.44
1:A:109:GLY:HA2	1:A:200:ILE:HD13	2.00	0.43
1:B:108:PRO:HG3	1:B:134:PHE:CE1	2.53	0.42
1:B:114:VAL:HG11	1:B:140:PHE:CE1	2.55	0.42
1:B:140:PHE:HD2	1:B:172:HIS:CG	2.39	0.41
1:A:113:SER:O	1:A:149:GLY:HA2	2.22	0.40

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	292/298 (98%)	288 (99%)	3 (1%)	1 (0%)	37	25
1	B	296/298 (99%)	293 (99%)	3 (1%)	0	100	100
All	All	588/596 (99%)	581 (99%)	6 (1%)	1 (0%)	44	31

All (1) Ramachandran outliers are listed below:

Mol	Chain	Res	Type
1	A	141	LEU

### 5.3.2 Protein sidechains [i](#)

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	231/257 (90%)	229 (99%)	2 (1%)	75	72
1	B	214/257 (83%)	212 (99%)	2 (1%)	75	72
All	All	445/514 (87%)	441 (99%)	4 (1%)	75	72

All (4) residues with a non-rotameric sidechain are listed below:

Mol	Chain	Res	Type
1	A	27	LEU
1	A	141	LEU
1	B	90	LYS
1	B	139	SER



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

Mol	Chain	Res	Type
1	B	163	HIS

### 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

### 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	A	294/298 (98%)	0.66	33 (11%) 11 9	19, 29, 47, 67	0
1	B	298/298 (100%)	1.01	57 (19%) 4 3	19, 35, 55, 68	0
All	All	592/596 (99%)	0.84	90 (15%) 6 5	19, 33, 52, 68	0

All (90) RSRZ outliers are listed below:

Mol	Chain	Res	Type	RSRZ
1	B	140	PHE	8.9
1	A	141	LEU	7.6
1	A	140	PHE	7.2
1	B	141	LEU	5.7
1	A	213	ILE	5.2
1	B	142	ASN	4.7
1	A	282	LEU	4.3
1	B	24	THR	4.1
1	A	215	GLY	4.1
1	A	142	ASN	4.1
1	B	277	ASN	4.0
1	B	228	ASN	4.0
1	B	139	SER	3.9
1	B	249	ILE	3.9
1	A	296	VAL	3.9
1	A	139	SER	3.6
1	B	138	GLY	3.6
1	B	233	VAL	3.5
1	A	280	THR	3.4
1	A	210	ALA	3.4
1	B	232	LEU	3.4
1	B	278	GLY	3.4
1	A	297	VAL	3.3
1	B	255	ALA	3.3

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<b>Mol</b>	<b>Chain</b>	<b>Res</b>	<b>Type</b>	<b>RSRZ</b>
1	B	247	VAL	3.2
1	B	227	LEU	3.2
1	A	143	GLY	3.2
1	B	50	LEU	3.1
1	B	285	ALA	3.1
1	B	300	CYS	3.0
1	B	237	TYR	3.0
1	B	118	TYR	3.0
1	B	72	ASN	3.0
1	B	3	PHE	3.0
1	A	154	TYR	2.9
1	B	45	THR	2.9
1	B	154	TYR	2.9
1	B	189	GLN	2.9
1	B	286	LEU	2.9
1	A	138	GLY	2.8
1	B	143	GLY	2.8
1	A	194	ALA	2.8
1	A	284	SER	2.8
1	B	238	ASN	2.8
1	B	153	ASP	2.8
1	A	291	PHE	2.7
1	B	230	PHE	2.7
1	A	169	THR	2.7
1	B	225	THR	2.7
1	A	277	ASN	2.6
1	B	229	ASP	2.6
1	B	49	MET	2.5
1	B	235	MET	2.5
1	B	282	LEU	2.5
1	A	196	THR	2.5
1	B	155	ASP	2.5
1	B	137	LYS	2.5
1	A	295	ASP	2.4
1	B	47	GLU	2.4
1	A	170	GLY	2.4
1	B	190	THR	2.4
1	A	72	ASN	2.4
1	A	212	VAL	2.4
1	B	234	ALA	2.4
1	B	224	THR	2.4
1	B	188	ARG	2.3

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Mol	Chain	Res	Type	RSRZ
1	B	59	ILE	2.3
1	A	216	ASP	2.3
1	B	226	THR	2.3
1	B	74	GLN	2.3
1	B	57	LEU	2.3
1	A	4	ARG	2.2
1	A	253	LEU	2.2
1	B	168	PRO	2.2
1	B	294	PHE	2.2
1	A	281	ILE	2.2
1	B	261	VAL	2.2
1	A	191	ALA	2.2
1	B	279	ARG	2.2
1	B	23	GLY	2.1
1	B	216	ASP	2.1
1	A	153	ASP	2.1
1	B	236	LYS	2.1
1	A	47	GLU	2.1
1	A	195	GLY	2.1
1	A	259	ILE	2.1
1	B	218	TRP	2.1
1	B	243	THR	2.1
1	B	283	GLY	2.1
1	B	44	CYS	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](#)

There are no ligands in this entry.

## 6.5 Other polymers [i](#)

There are no such residues in this entry.