



Full wwPDB X-ray Structure Validation Report ⓘ

Mar 9, 2026 – 01:54 PM UTC

PDB ID : 7VAH / pdb_00007vah
Title : The crystal structure of COVID-19 main protease in H41A mutation
Authors : Liu, X.; Zhao, Y.; Yang, H.; Rao, Z.
Deposited on : 2021-08-29
Resolution : 1.49 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 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

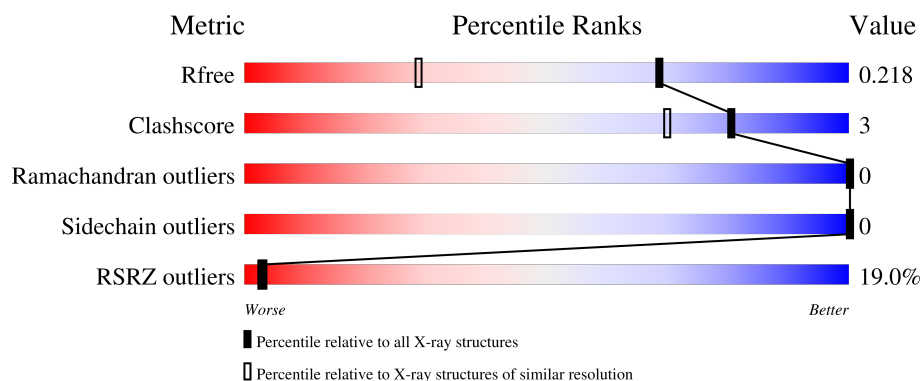
1 Overall quality at a glance

The following experimental techniques were used to determine the structure:

X-RAY DIFFRACTION

The reported resolution of this entry is 1.49 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	4037 (1.50-1.50)
Clashscore	190562	4235 (1.50-1.50)
Ramachandran outliers	187476	4153 (1.50-1.50)
Sidechain outliers	187428	4150 (1.50-1.50)
RSRZ outliers	180081	4039 (1.50-1.50)

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	306	19% 94% 6%

2 Entry composition

There are 2 unique types of molecules in this entry. The entry contains 2734 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 3C-like proteinase.

Mol	Chain	Residues	Atoms					ZeroOcc	AltConf	Trace
			Total	C	N	O	S			
1	A	306	2381	1507	401	449	24	0	4	0

There is a discrepancy between the modelled and reference sequences:

Chain	Residue	Modelled	Actual	Comment	Reference
A	41	ALA	HIS	engineered mutation	UNP P0DTD1

- Molecule 2 is water.

Mol	Chain	Residues	Atoms		ZeroOcc	AltConf
2	A	353	Total	O	0	0
			353	353		

- Molecule 1: 3C-like proteinase

4 Data and refinement statistics

Property	Value	Source
Space group	C 1 2 1	Depositor
Cell constants a, b, c, α , β , γ	98.20Å 83.05Å 51.60Å 90.00° 115.58° 90.00°	Depositor
Resolution (Å)	42.54 – 1.49 42.54 – 1.49	Depositor EDS
% Data completeness (in resolution range)	98.9 (42.54-1.49) 99.0 (42.54-1.49)	Depositor EDS
R_{merge}	0.04	Depositor
R_{sym}	(Not available)	Depositor
$\langle I/\sigma(I) \rangle$ ¹	3.24 (at 1.49Å)	Xtriage
Refinement program	PHENIX 1.14_3260	Depositor
R, R_{free}	0.193 , 0.217 0.195 , 0.218	Depositor DCC
R_{free} test set	3032 reflections (4.99%)	wwPDB-VP
Wilson B-factor (Å ²)	24.4	Xtriage
Anisotropy	0.288	Xtriage
Bulk solvent k_{sol} (e/Å ³), B_{sol} (Å ²)	0.33 , 36.3	EDS
L-test for twinning ²	$\langle L \rangle = 0.49$, $\langle L^2 \rangle = 0.32$	Xtriage
Estimated twinning fraction	No twinning to report.	Xtriage
F_o, F_c correlation	0.97	EDS
Total number of atoms	2734	wwPDB-VP
Average B, all atoms (Å ²)	34.0	wwPDB-VP

Xtriage's analysis on translational NCS is as follows: *The largest off-origin peak in the Patterson function is 7.02% 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	0.17	0/2442	0.40	0/3318

There are no bond length outliers.

There are no bond angle outliers.

There are no chirality outliers.

There are no planarity outliers.

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	2381	0	2332	12	0
2	A	353	0	0	5	0
All	All	2734	0	2332	12	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 (12) 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:110:GLN:HG3	2:A:610:HOH:O	1.90	0.71
1:A:50:LEU:HA	1:A:189:GLN:HB2	1.77	0.67
1:A:40:ARG:HA	1:A:87:LEU:HG	1.81	0.62
1:A:277:ASN:HB2	2:A:680:HOH:O	2.04	0.58

Continued on next page...

Continued from previous page...

Atom-1	Atom-2	Interatomic distance (Å)	Clash overlap (Å)
1:A:279:ARG:NH2	2:A:411:HOH:O	2.40	0.54
1:A:306:GLN:NE2	2:A:406:HOH:O	2.37	0.53
1:A:109:GLY:HA2	1:A:200:ILE:HD13	1.92	0.52
1:A:145[B]:CYS:SG	2:A:518:HOH:O	2.21	0.51
1:A:86:VAL:HG13	1:A:179:GLY:HA2	1.95	0.49
1:A:39:PRO:HG2	1:A:145[B]:CYS:SG	2.53	0.49
1:A:245:ASP:O	1:A:249:ILE:HG12	2.19	0.42
1:A:113:SER:O	1:A:149:GLY:HA2	2.21	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	308/306 (101%)	305 (99%)	3 (1%)	0	100	100

There are no Ramachandran outliers to report.

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	266/262 (102%)	266 (100%)	0	100	100

There are no protein residues with a non-rotameric sidechain to report.

Sometimes sidechains can be flipped to improve hydrogen bonding and reduce clashes. All (2) such sidechains are listed below:

Mol	Chain	Res	Type
1	A	119	ASN
1	A	180	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 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, 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	306/306 (100%)	1.10	58 (18%) 3 3	13, 31, 53, 82	4 (1%)

All (58) RSRZ outliers are listed below:

Mol	Chain	Res	Type	RSRZ
1	A	50	LEU	5.2
1	A	215	GLY	5.0
1	A	154	TYR	4.3
1	A	189	GLN	4.2
1	A	216	ASP	4.0
1	A	305	PHE	3.9
1	A	232	LEU	3.7
1	A	67	LEU	3.7
1	A	230	PHE	3.6
1	A	242	LEU	3.4
1	A	49	MET	3.4
1	A	249	ILE	3.3
1	A	227	LEU	3.3
1	A	262	LEU	3.1
1	A	128	CYS	3.1
1	A	303	VAL	3.1
1	A	24	THR	3.1
1	A	214	ASN	3.0
1	A	241	PRO	3.0
1	A	234	ALA	3.0
1	A	223	PHE	3.0
1	A	285	ALA	2.9
1	A	73	VAL	2.9
1	A	218	TRP	2.9
1	A	237	TYR	2.9
1	A	45	THR	2.9
1	A	302	GLY	2.8

Continued on next page...

Continued from previous page...

Mol	Chain	Res	Type	RSRZ
1	A	294	PHE	2.8
1	A	233	VAL	2.8
1	A	46	SER	2.8
1	A	278	GLY	2.8
1	A	26	THR	2.7
1	A	304	THR	2.7
1	A	286	LEU	2.5
1	A	72	ASN	2.5
1	A	74	GLN	2.5
1	A	64	HIS	2.5
1	A	71	GLY	2.4
1	A	306	GLN	2.4
1	A	231	ASN	2.4
1	A	225	THR	2.3
1	A	70	ALA	2.2
1	A	228	ASN	2.2
1	A	275	GLY	2.2
1	A	59	ILE	2.1
1	A	104	VAL	2.1
1	A	301	SER	2.1
1	A	196	THR	2.1
1	A	51	ASN	2.1
1	A	245	ASP	2.1
1	A	226	THR	2.1
1	A	243	THR	2.1
1	A	87	LEU	2.1
1	A	258	GLY	2.1
1	A	47	GLU	2.0
1	A	255	ALA	2.0
1	A	267	SER	2.0
1	A	155	ASP	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 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.