



Full wwPDB X-ray Structure Validation Report ⓘ

Jun 3, 2020 – 12:10 PM EDT

PDB ID : 6LU7
Title : The crystal structure of COVID-19 main protease in complex with an inhibitor N3
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Deposited on : 2020-01-26
Resolution : 2.16 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
Mogul : 1.8.5 (274361), CSD as541be (2020)
Xtriage (Phenix) : 1.13
EDS : 2.10.1
Percentile statistics : 20171227.v01 (using entries in the PDB archive December 27th 2017)
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) : 2.10.1

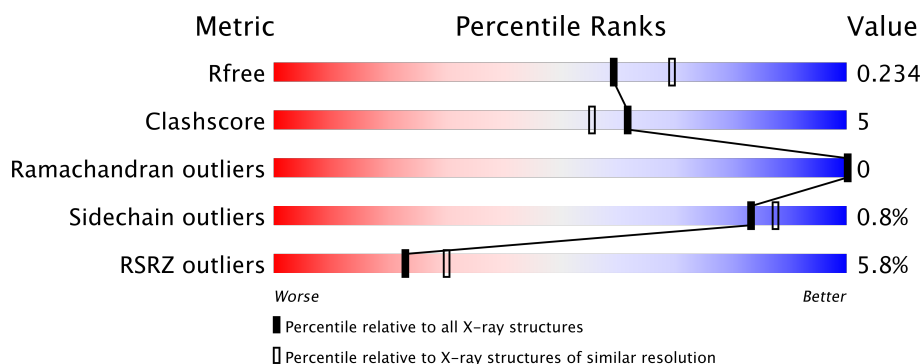
1 Overall quality at a glance

The following experimental techniques were used to determine the structure:

X-RAY DIFFRACTION

The reported resolution of this entry is 2.16 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}	111664	1287 (2.16-2.16)
Clashscore	122126	1390 (2.16-2.16)
Ramachandran outliers	120053	1368 (2.16-2.16)
Sidechain outliers	120020	1367 (2.16-2.16)
RSRZ outliers	108989	1262 (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 on 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	
2	C	6	

2 Entry composition

There are 3 unique types of molecules in this entry. The entry contains 2500 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 main protease.

Mol	Chain	Residues	Atoms					ZeroOcc	AltConf	Trace
1	A	306	Total	C	N	O	S	0	0	0
			2367	1499	402	444	22			

- Molecule 2 is a protein called N-[(5-METHYLISOXAZOL-3-YL)CARBONYL]ALANYL-L-VALYL-N 1 -((1R,2Z)-4-(BENZYLOXY)-4-OXO-1-{[(3R)-2-OXOPYRROLIDIN-3-YL]METHYL}BUT-2-ENYL)-L-LEUCINAMIDE.

Mol	Chain	Residues	Atoms				ZeroOcc	AltConf	Trace
2	C	6	Total	C	N	O	0	0	0
			49	35	6	8			

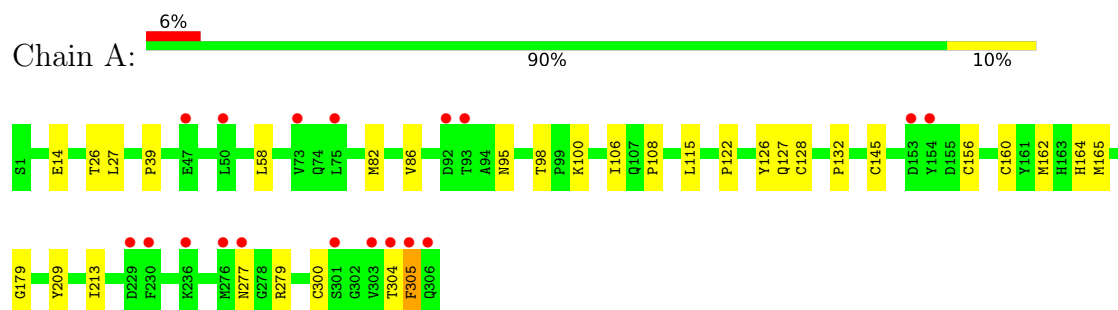
- Molecule 3 is water.

Mol	Chain	Residues	Atoms		ZeroOcc	AltConf
3	A	84	Total	O	0	0
			84	84		

3 Residue-property plots [i](#)

These plots are drawn for all protein, RNA and DNA 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: main protease



- Molecule 2: N-[(5-METHYLISOXAZOL-3-YL)CARBONYL]ALANYL-L-VALYL-N 1 -((1R,2Z)-4-(BENZYL OXY)-4-OXO-1-[(3R)-2-OXOPYRROLIDIN-3-YL]METHYL}BUT-2-ENYL)-L-L EUCINAMIDE



4 Data and refinement statistics

Property	Value	Source
Space group	C 1 2 1	Depositor
Cell constants a, b, c, α , β , γ	97.93Å 79.48Å 51.80Å 90.00° 114.55° 90.00°	Depositor
Resolution (Å)	27.81 – 2.16 42.31 – 2.16	Depositor EDS
% Data completeness (in resolution range)	99.5 (27.81-2.16) 99.6 (42.31-2.16)	Depositor EDS
R_{merge}	0.19	Depositor
R_{sym}	(Not available)	Depositor
$\langle I/\sigma(I) \rangle$ ¹	3.09 (at 2.16Å)	Xtriage
Refinement program	PHENIX 1.17.1 _3660	Depositor
R, R_{free}	0.202 , 0.235 0.201 , 0.234	Depositor DCC
R_{free} test set	998 reflections (5.13%)	wwPDB-VP
Wilson B-factor (Å ²)	34.7	Xtriage
Anisotropy	0.488	Xtriage
Bulk solvent k_{sol} (e/Å ³), B_{sol} (Å ²)	0.34 , 47.3	EDS
L-test for twinning ²	$\langle L \rangle = 0.47$, $\langle L^2 \rangle = 0.29$	Xtriage
Estimated twinning fraction	No twinning to report.	Xtriage
F_o, F_c correlation	0.94	EDS
Total number of atoms	2500	wwPDB-VP
Average B, all atoms (Å ²)	42.0	wwPDB-VP

Xtriage's analysis on translational NCS is as follows: *The largest off-origin peak in the Patterson function is 7.73% 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](#)

Bond lengths and bond angles in the following residue types are not validated in this section: 010, PJE, 02J

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	0.25	0/2420	0.44	0/3289
2	C	2.42	1/19 (5.3%)	0.74	0/25
All	All	0.33	1/2439 (0.0%)	0.44	0/3314

All (1) bond length outliers are listed below:

Mol	Chain	Res	Type	Atoms	Z	Observed(Å)	Ideal(Å)
2	C	3	VAL	C-N	7.48	1.51	1.34

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	2367	0	2313	23	0
2	C	49	0	46	4	0
3	A	84	0	0	1	1
All	All	2500	0	2359	23	1

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 5.

All (23) 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:26:THR:H	2:C:6:010:H4	1.45	0.82
1:A:106:ILE:C	1:A:106:ILE:HD12	2.10	0.71
1:A:115:LEU:HD11	1:A:122:PRO:HB3	1.83	0.61
1:A:100:LYS:HD3	1:A:156:CYS:HB2	1.85	0.59
1:A:145:CYS:H	2:C:5:PJE:H4	1.72	0.54
1:A:86:VAL:HG13	1:A:179:GLY:HA2	1.94	0.49
1:A:126:TYR:HE2	1:A:128:CYS:HG	1.61	0.48
1:A:27:LEU:HD13	1:A:39:PRO:HD2	1.96	0.48
1:A:108:PRO:HB3	1:A:132:PRO:HA	1.95	0.48
1:A:213:ILE:HG21	1:A:300:CYS:HB3	1.96	0.47
1:A:106:ILE:C	1:A:106:ILE:CD1	2.80	0.47
1:A:127:GLN:NE2	3:A:408:HOH:O	2.48	0.47
1:A:95:ASN:HB3	1:A:98:THR:OG1	2.14	0.47
1:A:277:ASN:OD1	1:A:279:ARG:NH2	2.48	0.46
1:A:106:ILE:O	1:A:106:ILE:HD12	2.16	0.45
1:A:58:LEU:HD22	1:A:82:MET:HB2	1.99	0.45
1:A:304:THR:HG23	1:A:305:PHE:H	1.83	0.43
1:A:106:ILE:HG23	1:A:160:CYS:HB2	2.01	0.42
1:A:165:MET:HB3	2:C:4:LEU:HD12	2.02	0.42
1:A:26:THR:N	2:C:6:010:H4	2.24	0.42
1:A:14:GLU:HG2	1:A:122:PRO:HG2	2.01	0.42
1:A:209:TYR:O	1:A:213:ILE:HG13	2.21	0.41
1:A:162:MET:O	1:A:164:HIS:HD2	2.03	0.41

All (1) symmetry-related close contacts are listed below. The label for Atom-2 includes the symmetry operator and encoded unit-cell translations to be applied.

Atom-1	Atom-2	Interatomic distance (Å)	Clash overlap (Å)
3:A:402:HOH:O	3:A:402:HOH:O[2_558]	2.14	0.06

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	304/306 (99%)	295 (97%)	9 (3%)	0	100	100
2	C	1/6 (17%)	1 (100%)	0	0	100	100
All	All	305/312 (98%)	296 (97%)	9 (3%)	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	263/263 (100%)	262 (100%)	1 (0%)	92	94
2	C	2/2 (100%)	1 (50%)	1 (50%)	0	0
All	All	265/265 (100%)	263 (99%)	2 (1%)	83	87

All (2) residues with a non-rotameric sidechain are listed below:

Mol	Chain	Res	Type
1	A	305	PHE
2	C	4	LEU

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

Mol	Chain	Res	Type
1	A	164	HIS

5.3.3 RNA ⓘ

There are no RNA molecules in this entry.

5.4 Non-standard residues in protein, DNA, RNA chains ⓘ

2 non-standard protein/DNA/RNA residues are 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$
2	PJE	C	5	1,2	12,13,14	10.60	9 (75%)	12,16,18	5.65	7 (58%)
2	02J	C	1	2	6,8,9	2.81	3 (50%)	4,10,12	2.65	2 (50%)

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
2	PJE	C	5	1,2	-	2/7/18/19	0/1/1/1
2	02J	C	1	2	-	0/0/2/4	0/1/1/1

All (12) bond length outliers are listed below:

Mol	Chain	Res	Type	Atoms	Z	Observed(Å)	Ideal(Å)
2	C	5	PJE	C29-N6	26.52	1.61	1.33
2	C	5	PJE	C26-C29	-18.63	1.29	1.52
2	C	5	PJE	C27-C28	-11.06	1.35	1.53
2	C	5	PJE	O8-C29	10.03	1.43	1.23
2	C	5	PJE	C21-C20	5.37	1.54	1.33
2	C	1	02J	C3-C41	5.25	1.54	1.48
2	C	5	PJE	C27-C26	3.90	1.64	1.54
2	C	5	PJE	C21-C22	3.80	1.55	1.44
2	C	1	02J	C6-C5	3.52	1.52	1.48
2	C	5	PJE	C25-C26	2.98	1.60	1.53
2	C	5	PJE	C28-N6	2.49	1.51	1.46
2	C	1	02J	C4-C3	2.04	1.43	1.39

All (9) bond angle outliers are listed below:

Mol	Chain	Res	Type	Atoms	Z	Observed(°)	Ideal(°)
2	C	5	PJE	O8-C29-C26	-11.97	112.16	126.23
2	C	5	PJE	O8-C29-N6	-11.07	110.18	125.54
2	C	5	PJE	C19-C20-C21	-8.10	112.84	124.41
2	C	1	02J	O42-C41-C3	-4.62	119.84	124.22
2	C	5	PJE	C27-C26-C29	4.31	108.48	102.88
2	C	5	PJE	C28-N6-C29	-4.01	105.97	113.84
2	C	5	PJE	C27-C28-N6	2.44	107.01	103.43
2	C	1	02J	C4-C3-N2	-2.23	105.92	109.94
2	C	5	PJE	C25-C26-C27	-2.01	109.91	117.31

There are no chirality outliers.

All (2) torsion outliers are listed below:

Mol	Chain	Res	Type	Atoms
2	C	5	PJE	C19-C20-C21-C22
2	C	5	PJE	C20-C21-C22-O7

There are no ring outliers.

1 monomer is involved in 1 short contact:

Mol	Chain	Res	Type	Clashes	Symm-Clashes
2	C	5	PJE	1	0

5.5 Carbohydrates [i](#)

There are no carbohydrates 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%)	0.51	18 (5%) 22 29	23, 42, 62, 81	0
2	C	3/6 (50%)	0.62	0 100 100	39, 39, 41, 42	0
All	All	309/312 (99%)	0.51	18 (5%) 23 30	23, 42, 62, 81	0

All (18) RSRZ outliers are listed below:

Mol	Chain	Res	Type	RSRZ
1	A	305	PHE	7.9
1	A	304	THR	6.5
1	A	306	GLN	5.1
1	A	277	ASN	4.4
1	A	154	TYR	4.0
1	A	73	VAL	3.7
1	A	303	VAL	3.7
1	A	93	THR	3.7
1	A	92	ASP	3.6
1	A	153	ASP	3.0
1	A	301	SER	2.9
1	A	276	MET	2.5
1	A	230	PHE	2.4
1	A	50	LEU	2.3
1	A	236	LYS	2.3
1	A	47	GLU	2.1
1	A	75	LEU	2.1
1	A	229	ASP	2.0

6.2 Non-standard residues in protein, DNA, RNA chains

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, 95th 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(\AA^2)	Q<0.9
2	02J	C	1	8/9	0.84	0.29	47,54,63,64	0
2	PJE	C	5	13/14	0.85	0.18	30,35,52,57	0

6.3 Carbohydrates [i](#)

There are no carbohydrates 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.