Full wwPDB X-ray Structure Validation Report ⓘ

Oct 14, 2023 – 10:25 PM EDT

PDB ID	:	8DKL
Title	:	Polymorphism in SARS-CoV-2 Nsp5 main protease reveals differences in cleavage of viral and host substrates
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Deposited on	:	2022-07-05
Resolution	:	1.90 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:

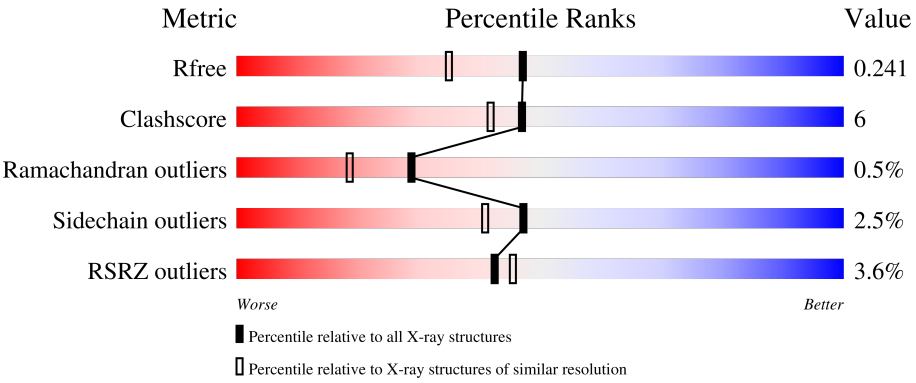
MolProbity	:	4.02b-467
Xtriage (Phenix)	:	1.13
EDS	:	2.36
Percentile statistics	:	20191225.v01 (using entries in the PDB archive December 25th 2019)
Refmac	:	5.8.0158
CCP4	:	7.0.044 (Gargrove)
Ideal geometry (proteins)	:	Engh & Huber (2001)
Ideal geometry (DNA, RNA)	:	Parkinson et al. (1996)
Validation Pipeline (wwPDB-VP)	:	2.36

1 Overall quality at a glance (i)

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

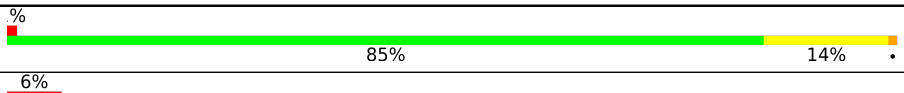
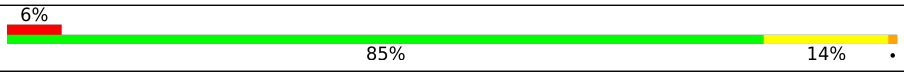
The reported resolution of this entry is 1.90 Å.

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	6207 (1.90-1.90)
Clashscore	141614	6847 (1.90-1.90)
Ramachandran outliers	138981	6760 (1.90-1.90)
Sidechain outliers	138945	6760 (1.90-1.90)
RSRZ outliers	127900	6082 (1.90-1.90)

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 <=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	
1	B	306	

2 Entry composition (i)

There are 2 unique types of molecules in this entry. The entry contains 5062 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 nsp5.

Mol	Chain	Residues	Atoms					ZeroOcc	AltConf	Trace
1	A	306	Total	C	N	O	S	0	2	0
			2381	1509	405	444	23			
1	B	306	Total	C	N	O	S	0	2	0
			2381	1509	405	444	23			

There are 2 discrepancies between the modelled and reference sequences:

Chain	Residue	Modelled	Actual	Comment	Reference
A	89	PHE	LEU	engineered mutation	UNP P0DTD1
B	89	PHE	LEU	engineered mutation	UNP P0DTD1

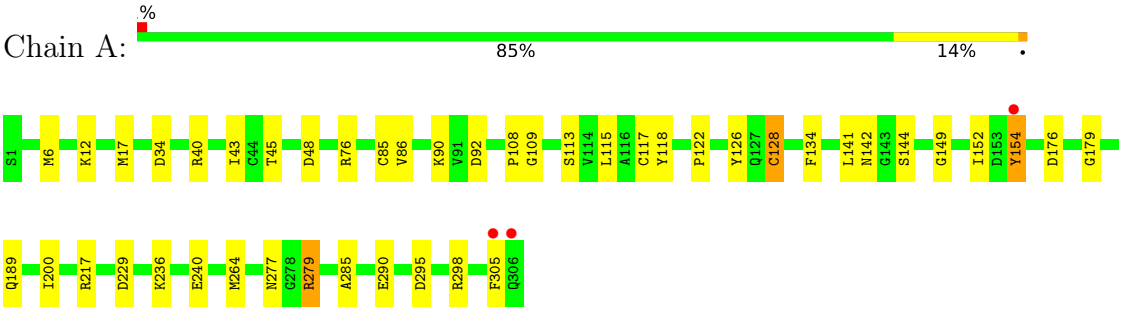
- Molecule 2 is water.

Mol	Chain	Residues	Atoms		ZeroOcc	AltConf
2	A	187	Total	O	0	0
			187	187		
2	B	113	Total	O	0	0
			113	113		

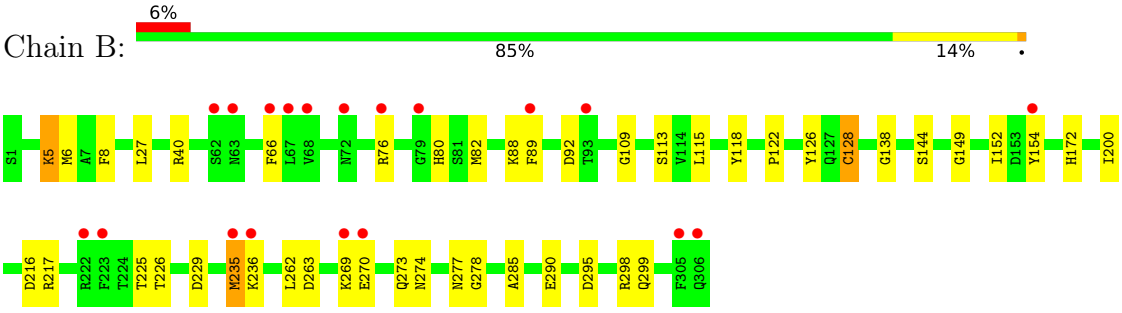
3 Residue-property plots (i)

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: 3C-like proteinase nsp5



• Molecule 1: 3C-like proteinase nsp5



4 Data and refinement statistics (i)

Property	Value	Source
Space group	P 1 21 1	Depositor
Cell constants a, b, c, α, β, γ	44.96Å 53.80Å 114.76Å 90.00° 101.36° 90.00°	Depositor
Resolution (Å)	38.58 – 1.90 38.88 – 1.85	Depositor EDS
% Data completeness (in resolution range)	97.9 (38.58-1.90) 97.6 (38.88-1.85)	Depositor EDS
R_{merge}	(Not available)	Depositor
R_{sym}	(Not available)	Depositor
$< I/\sigma(I) >$ [1]	1.19 (at 1.85Å)	Xtriage
Refinement program	PHENIX 1.19.2_4158	Depositor
R, R_{free}	0.200 , 0.241 0.200 , 0.241	Depositor DCC
R_{free} test set	2246 reflections (5.00%)	wwPDB-VP
Wilson B-factor (Å^2)	30.3	Xtriage
Anisotropy	0.313	Xtriage
Bulk solvent k_{sol}(e/Å^3), B_{sol}(Å^2)	0.36 , 47.7	EDS
L-test for twinning[2]	$< \|L\| > = 0.49$, $< L^2 > = 0.32$	Xtriage
Estimated twinning fraction	0.000 for h,-k,-h-l	Xtriage
F_o,F_c correlation	0.97	EDS
Total number of atoms	5062	wwPDB-VP
Average B, all atoms (Å^2)	36.0	wwPDB-VP

Xtriage's analysis on translational NCS is as follows: *The analyses of the Patterson function reveals a significant off-origin peak that is 83.70 % of the origin peak, indicating pseudo-translational symmetry. The chance of finding a peak of this or larger height randomly in a structure without pseudo-translational symmetry is equal to 2.0253e-07. The detected translational NCS is most likely also responsible for the elevated intensity ratio.*

[1] Intensities estimated from amplitudes.

[2] Theoretical values of $< |L| >$, $< L^2 >$ 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

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	0.47	0/2441	0.68	0/3316
1	B	0.44	0/2441	0.67	0/3316
All	All	0.46	0/4882	0.68	0/6632

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	235	MET	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	A	2381	0	2330	29	0
1	B	2381	0	2330	31	0
2	A	187	0	0	7	0

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Mol	Chain	Non-H	H(model)	H(added)	Clashes	Symm-Clashes
2	B	113	0	0	6	0
All	All	5062	0	4660	58	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 6.

All (58) 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:270:GLU:OE1	1:B:274:ASN:ND2	1.95	0.99
1:B:273:GLN:OE1	2:B:401:HOH:O	1.81	0.98
1:B:138:GLY:H	1:B:172:HIS:HD2	1.28	0.79
1:B:295:ASP:OD1	1:B:298[B]:ARG:NH2	2.25	0.70
1:B:229:ASP:OD2	1:B:269:LYS:NZ	2.24	0.69
1:A:229:ASP:OD1	2:A:402:HOH:O	2.12	0.67
1:B:217:ARG:NH1	2:B:402:HOH:O	2.27	0.66
1:A:236:LYS:O	2:A:403:HOH:O	2.16	0.62
1:B:138:GLY:H	1:B:172:HIS:CD2	2.14	0.61
1:A:285:ALA:HB3	1:B:285:ALA:HB3	1.84	0.60
1:B:115:LEU:HD11	1:B:122:PRO:HB3	1.84	0.59
1:A:176:ASP:OD2	2:A:404:HOH:O	2.16	0.59
1:B:225:THR:HG22	1:B:226:THR:O	2.03	0.59
1:B:6:MET:HE3	1:B:299:GLN:HG3	1.84	0.59
1:B:76:ARG:HB3	1:B:92:ASP:HB2	1.87	0.56
1:B:273:GLN:CD	2:B:401:HOH:O	2.35	0.56
1:B:229:ASP:HB3	2:B:406:HOH:O	2.05	0.55
1:A:34:ASP:OD2	1:A:90:LYS:HE2	2.06	0.55
1:B:66:PHE:CG	1:B:89:PHE:HE1	2.24	0.55
1:A:109:GLY:HA2	1:A:200:ILE:HD13	1.89	0.54
1:A:17:MET:HG3	1:A:117:CYS:SG	2.48	0.54
1:B:273:GLN:NE2	2:B:401:HOH:O	2.41	0.53
1:A:40:ARG:O	1:A:43:ILE:HG12	2.09	0.53
1:A:264:MET:O	1:A:264:MET:HG3	2.08	0.53
1:B:8:PHE:HB3	1:B:152:ILE:HD12	1.91	0.53
1:A:126:TYR:HE1	1:A:128[A]:CYS:HG	1.57	0.52
1:A:126:TYR:HE1	1:A:128[A]:CYS:SG	2.32	0.52
1:B:109:GLY:HA2	1:B:200:ILE:HD13	1.91	0.52
1:B:40:ARG:HH11	1:B:82:MET:HE3	1.75	0.51
1:A:141:LEU:HD11	1:B:299:GLN:O	2.12	0.50
1:B:126:TYR:HE1	1:B:128[A]:CYS:HG	1.60	0.50
1:A:76:ARG:HB3	1:A:92:ASP:HB2	1.94	0.49

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Atom-1	Atom-2	Interatomic distance (Å)	Clash overlap (Å)
1:A:240:GLU:OE1	2:A:406:HOH:O	2.17	0.49
1:B:76:ARG:HH11	1:B:76:ARG:HG3	1.78	0.48
1:A:118:TYR:CE2	1:A:144:SER:HB3	2.49	0.48
1:A:86:VAL:HG13	1:A:179:GLY:HA2	1.95	0.48
1:A:115:LEU:HD11	1:A:122:PRO:HB3	1.94	0.48
1:A:113:SER:O	1:A:149:GLY:HA2	2.14	0.47
1:B:118:TYR:CE2	1:B:144:SER:HB3	2.49	0.47
1:B:225:THR:O	1:B:262:LEU:HD13	2.14	0.47
1:B:5:LYS:HE2	1:B:290:GLU:HB2	1.97	0.47
1:A:217:ARG:NH2	2:A:401:HOH:O	2.04	0.46
1:A:295:ASP:OD1	1:A:298[B]:ARG:NH2	2.49	0.45
1:B:40:ARG:NH1	1:B:82:MET:HE3	2.31	0.45
1:A:142:ASN:ND2	2:A:412:HOH:O	2.50	0.45
1:A:40:ARG:HD3	1:A:85:CYS:HA	1.99	0.44
1:A:290:GLU:OE2	2:A:407:HOH:O	2.21	0.44
1:B:66:PHE:CG	1:B:89:PHE:CE1	3.05	0.43
1:A:12:LYS:HE2	1:A:152:ILE:HD13	2.01	0.43
1:A:108:PRO:HG3	1:A:134:PHE:CE1	2.54	0.43
1:A:154:TYR:H	1:A:305:PHE:HD1	1.68	0.42
1:B:277:ASN:HB3	1:B:278:GLY:H	1.60	0.42
1:B:82:MET:HE3	2:B:421:HOH:O	2.20	0.41
1:A:45:THR:OG1	1:A:48:ASP:OD2	2.37	0.41
1:B:113:SER:O	1:B:149:GLY:HA2	2.20	0.41
1:A:108:PRO:HG3	1:A:134:PHE:CZ	2.56	0.41
1:B:138:GLY:N	1:B:172:HIS:HD2	2.07	0.41
1:A:279:ARG:NH1	1:A:279:ARG:HB3	2.36	0.41

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	306/306 (100%)	299 (98%)	6 (2%)	1 (0%)	41 31
1	B	306/306 (100%)	291 (95%)	13 (4%)	2 (1%)	22 12
All	All	612/612 (100%)	590 (96%)	19 (3%)	3 (0%)	29 18

All (3) Ramachandran outliers are listed below:

Mol	Chain	Res	Type
1	B	236	LYS
1	A	154	TYR
1	B	154	TYR

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	265/263 (101%)	259 (98%)	6 (2%)	50 45
1	B	265/263 (101%)	256 (97%)	9 (3%)	37 28
All	All	530/526 (101%)	515 (97%)	15 (3%)	47 36

All (15) residues with a non-rotameric sidechain are listed below:

Mol	Chain	Res	Type
1	A	6	MET
1	A	128[A]	CYS
1	A	128[B]	CYS
1	A	189	GLN
1	A	277	ASN
1	A	279	ARG
1	B	5	LYS
1	B	27	LEU
1	B	80	HIS
1	B	88	LYS
1	B	128[A]	CYS
1	B	128[B]	CYS
1	B	216	ASP

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Mol	Chain	Res	Type
1	B	235	MET
1	B	263	ASP

Sometimes sidechains can be flipped to improve hydrogen bonding and reduce clashes. All (3) such sidechains are listed below:

Mol	Chain	Res	Type
1	B	172	HIS
1	B	189	GLN
1	B	214	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

There are no ligands in this entry.

5.7 Other polymers

There are no such residues in this entry.

5.8 Polymer linkage issues

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^{th} 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%)	-0.16	3 (0%)	82	84	21, 32, 47, 67	0
1	B	306/306 (100%)	0.17	19 (6%)	20	23	22, 37, 61, 77	0
All	All	612/612 (100%)	0.00	22 (3%)	42	45	21, 34, 57, 77	0

All (22) RSRZ outliers are listed below:

Mol	Chain	Res	Type	RSRZ
1	B	306	GLN	6.3
1	A	306	GLN	5.3
1	B	154	TYR	5.2
1	A	154	TYR	4.9
1	B	62	SER	3.8
1	A	305	PHE	3.8
1	B	67	LEU	3.8
1	B	235	MET	3.1
1	B	63	ASN	3.0
1	B	72	ASN	3.0
1	B	89	PHE	2.9
1	B	223	PHE	2.8
1	B	66	PHE	2.7
1	B	305	PHE	2.7
1	B	93	THR	2.5
1	B	76	ARG	2.3
1	B	222	ARG	2.3
1	B	269	LYS	2.3
1	B	270	GLU	2.3
1	B	68	VAL	2.2
1	B	236	LYS	2.2
1	B	79	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)

There are no ligands in this entry.

6.5 Other polymers (i)

There are no such residues in this entry.