WORLDWIDE PDB PROTEIN DATA BANK

Full wwPDB X-ray Structure Validation Report (i)

Oct 15, 2023 – 04:32 PM EDT

PDB ID	:	8EJ7
Title	:	Polymorphism in SARS-CoV-2 Nsp5 main protease reveals differences in cleavage of viral and host substrates
Authors	:	Lu, J.; Khan, M.B.; Young, H.S.; Lemieux, M.J.
Deposited on	:	2022-09-16
Resolution	:	2.30 Å(reported)

The following versions of software and data (see references (i)) 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 ⓘ

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

The reported resolution of this entry is 2.30 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.
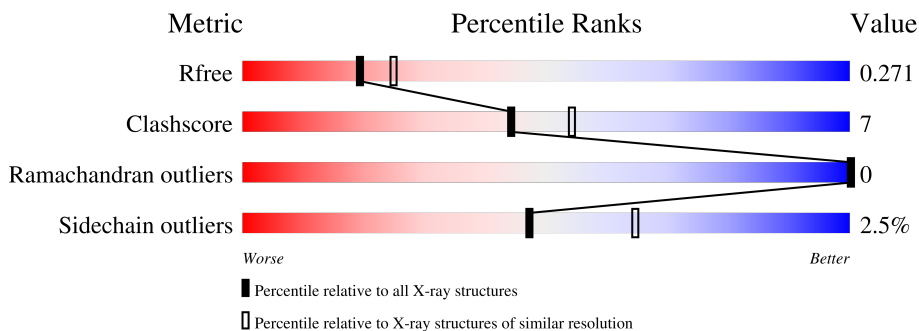
Metric	Whole archive (#Entries)	Similar resolution (#Entries, resolution range(Å))
R_{free}	130704	5042 (2.30-2.30)
Clashscore	141614	5643 (2.30-2.30)
Ramachandran outliers	138981	5575 (2.30-2.30)
Sidechain outliers	138945	5575 (2.30-2.30)

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%

Mol	Chain	Length	Quality of chain
1	A	306	82% 17% •
1	B	306	84% 15% •

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2 Entry composition ⓘ

There are 2 unique types of molecules in this entry. The entry contains 4960 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
			2378	1507	406	442	23			
1	B	306	Total	C	N	O	S	0	2	0
			2378	1507	406	442	23			

There are 2 discrepancies between the modelled and reference sequences:

Chain	Residue	Modelled	Actual	Comment	Reference
A	47	LYS	GLU	engineered mutation	UNP P0DTD1
B	47	LYS	GLU	engineered mutation	UNP P0DTD1

- Molecule 2 is water.

Mol	Chain	Residues	Atoms		ZeroOcc	AltConf
2	A	118	Total	O	0	0
			118	118		
2	B	86	Total	O	0	0
			86	86		

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. Residues are color-coded according to the number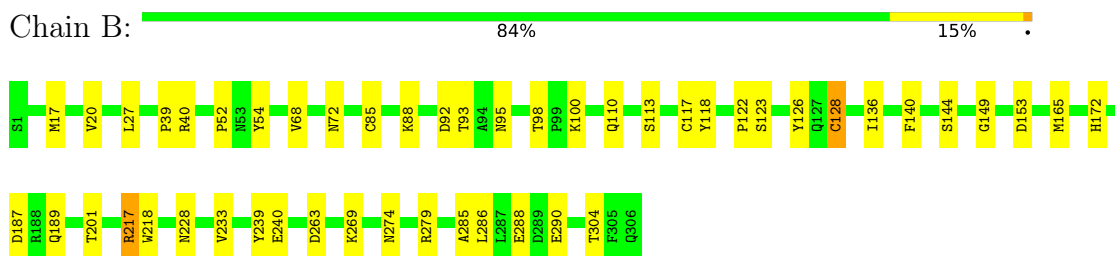 of geometric quality criteria for which they contain at least one outlier: green = 0, yellow = 1, orange = 2 and red = 3 or more. Stretches of 2 or more consecutive residues without any outlier are shown as a green connector. Residues present in the sample, but not in the model, are shown in grey.

- Molecule 1: 3C-like proteinase nsp5

Chain A:

- Molecule 1: 3C-like proteinase nsp5

Chain B:
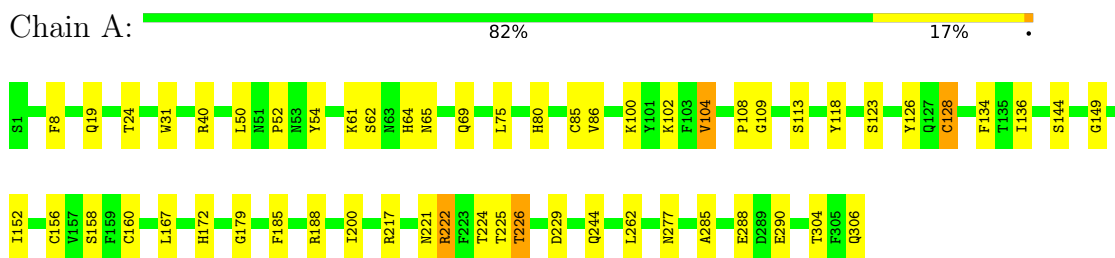
4 Data and refinement statistics ⓘ

Property	Value	Source
Space group	P 1 21 1	Depositor
Cell constants a, b, c, α, β, γ	44.87Å 54.10Å 114.01Å 90.00° 101.03° 90.00°	Depositor
Resolution (Å)	38.55 – 2.30 38.89 – 2.10	Depositor EDS
% Data completeness (in resolution range)	97.1 (38.55-2.30) 94.5 (38.89-2.10)	Depositor EDS
R_{merge}	(Not available)	Depositor
R_{sym}	(Not available)	Depositor
$<I/\sigma(I)>$ [1]	1.93 (at 2.10Å)	Xtriage
Refinement program	PHENIX 1.19.2_4158	Depositor
R, R_{free}	0.201 , 0.270 0.203 , 0.271	Depositor DCC
R_{free} test set	1501 reflections (5.01%)	wwPDB-VP
Wilson B-factor (Å^2)	24.2	Xtriage
Anisotropy	0.080	Xtriage
Bulk solvent k_{sol}(e/Å^3), B_{sol}(Å^2)	0.32 , 39.7	EDS
L-test for twinning [2]	$<|L|> = 0.50$, $<L^2> = 0.33$	Xtriage
Estimated twinning fraction	0.000 for h,-k,-h-l	Xtriage
F_o,F_c correlation	0.92	EDS
Total number of atoms	4960	wwPDB-VP
Average B, all atoms (Å^2)	37.0	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 88.67 % 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 4.5176e-08. The detected translational NCS is most likely also responsible for the elevated intensity ratio.*

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[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 (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	0.50	0/2437	0.69	3/3310 (0.1%)
1	B	0.45	0/2437	0.64	0/3310
All	All	0.48	0/4874	0.66	3/6620 (0.0%)

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	A	0	1
1	B	0	1
All	All	0	2

There are no bond length outliers.

All (3) bond angle outliers are listed below:

Mol	Chain	Res	Type	Atoms	Z	Observed(^{o})	Ideal(^{o})
1	A	222	ARG	CB-CG-CD	5.64	126.27	111.60
1	A	222	ARG	CG-CD-NE	-5.50	100.25	111.80
1	A	221	ASN	C-N-CA	-5.07	109.03	121.70

There are no chirality outliers.

All (2) planarity outliers are listed below:

Mol	Chain	Res	Type	Group
1	A	222	ARG	Sidechain
1	B	217	ARG	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	2378	0	2339	35	0
1	B	2378	0	2339	32	0
2	A	118	0	0	5	0
2	B	86	0	0	7	0
All	All	4960	0	4678	62	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 7.

All (62) 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:61:LYS:O	2:A:401:HOH:O	2.01	0.78
1:B:290:GLU:OE2	2:B:401:HOH:O	2.06	0.73
1:A:306:GLN:HA	1:B:122:PRO:HD2	1.68	0.73
1:B:274:ASN:ND2	2:B:406:HOH:O	2.27	0.67
1:B:240:GLU:OE1	2:B:403:HOH:O	2.14	0.65
1:B:240:GLU:OE2	2:B:402:HOH:O	2.13	0.65
1:B:126:TYR:HE1	1:B:128[A]:CYS:HG	1.46	0.64
1:A:8:PHE:HB3	1:A:152:ILE:HD12	1.81	0.62
1:A:126:TYR:HE1	1:A:128[A]:CYS:HG	1.50	0.59
1:A:118:TYR:CE1	1:A:144:SER:HB3	2.37	0.59
1:A:226:THR:HG23	1:A:229:ASP:HB2	1.85	0.59
1:A:285:ALA:HB3	1:B:285:ALA:HB3	1.86	0.57
1:B:228:ASN:HB2	2:B:428:HOH:O	2.05	0.56
1:B:165:MET:HE1	1:B:187:ASP:HA	1.87	0.56
1:A:109:GLY:HA2	1:A:200:ILE:HD13	1.86	0.56
1:A:188:ARG:HD3	2:A:501:HOH:O	2.11	0.52
1:B:201:THR:OG1	1:B:239:TYR:HB3	2.11	0.51
1:B:288:GLU:OE2	2:B:404:HOH:O	2.19	0.51
1:A:40:ARG:HD3	1:A:85:CYS:HA	1.93	0.50
1:A:123:SER:HB3	1:B:304:THR:HG22	1.94	0.50
1:A:167:LEU:HD11	1:A:185:PHE:CE1	2.46	0.50
1:A:80:HIS:O	2:A:403:HOH:O	2.19	0.50
1:A:225:THR:O	1:A:262:LEU:HD13	2.12	0.50

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Atom-1	Atom-2	Interatomic distance (Å)	Clash overlap (Å)
1:A:19:GLN:HB3	1:A:69:GLN:HB3	1.93	0.49
1:A:31:TRP:CZ2	1:A:75:LEU:HD21	2.48	0.49
1:A:62:SER:HB3	1:A:64:HIS:CE1	2.48	0.49
1:B:40:ARG:HD3	1:B:85:CYS:HA	1.95	0.49
1:B:92:ASP:OD1	1:B:93:THR:HG23	2.13	0.48
1:A:108:PRO:HG3	1:A:134:PHE:CZ	2.48	0.48
1:A:113:SER:O	1:A:149:GLY:HA2	2.14	0.48
1:B:17:MET:HG3	1:B:117:CYS:SG	2.54	0.48
1:A:86:VAL:HG13	1:A:179:GLY:HA2	1.97	0.47
1:A:31:TRP:CE2	1:A:75:LEU:HD21	2.50	0.47
1:B:110:GLN:HB3	2:B:447:HOH:O	2.14	0.47
1:A:52:PRO:HG2	1:A:54:TYR:CE2	2.50	0.46
1:B:27:LEU:HD13	1:B:39:PRO:HD2	1.95	0.46
1:A:126:TYR:HE1	1:A:128[A]:CYS:SG	2.39	0.46
1:A:244:GLN:HB2	2:A:458:HOH:O	2.15	0.46
1:B:118:TYR:CE1	1:B:144:SER:HB3	2.51	0.46
1:B:140:PHE:HB3	1:B:144:SER:OG	2.16	0.45
1:B:126:TYR:HE1	1:B:128[A]:CYS:SG	2.38	0.45
1:B:218:TRP:CD2	1:B:279:ARG:NH1	2.85	0.45
1:B:113:SER:O	1:B:149:GLY:HA2	2.18	0.44
1:A:102:LYS:HE3	1:A:158:SER:OG	2.18	0.44
1:B:95:ASN:HB3	1:B:98:THR:OG1	2.18	0.44
1:A:224:THR:OG1	1:A:225:THR:N	2.50	0.44
1:B:20:VAL:HG22	1:B:68:VAL:HG22	1.99	0.43
1:B:88:LYS:HB2	1:B:88:LYS:HE3	1.81	0.43
1:A:62:SER:O	1:A:65:ASN:HB2	2.18	0.43
1:A:288:GLU:OE1	1:A:290:GLU:HB2	2.18	0.43
1:A:104:VAL:O	1:A:160:CYS:HA	2.19	0.42
1:B:52:PRO:HG2	1:B:54:TYR:CE2	2.54	0.42
1:A:156:CYS:O	2:A:404:HOH:O	2.21	0.42
1:A:285:ALA:HB2	1:B:286:LEU:HD21	2.01	0.42
1:B:288:GLU:OE1	1:B:290:GLU:HB2	2.19	0.42
1:B:233:VAL:HG21	1:B:269:LYS:HG3	2.02	0.42
1:A:262:LEU:HD23	1:A:262:LEU:HA	1.77	0.41
1:A:304:THR:HG22	1:B:123:SER:HB3	2.02	0.41
1:A:136:ILE:CD1	1:A:172:HIS:HB2	2.50	0.41
1:B:136:ILE:HG13	1:B:172:HIS:HB2	2.02	0.41
1:A:50:LEU:O	1:A:188:ARG:NH2	2.53	0.41
1:B:100:LYS:HD2	1:B:100:LYS:HA	1.84	0.40

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	A	306/306 (100%)	299 (98%)	7 (2%)	0	100	100
1	B	306/306 (100%)	301 (98%)	5 (2%)	0	100	100
All	All	612/612 (100%)	600 (98%)	12 (2%)	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	265/263 (101%)	257 (97%)	8 (3%)	41	57
1	B	265/263 (101%)	258 (97%)	7 (3%)	46	63
All	All	530/526 (101%)	515 (97%)	15 (3%)	47	60

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

Mol	Chain	Res	Type
1	A	24	THR
1	A	100	LYS
1	A	104	VAL
1	A	128[A]	CYS
1	A	128[B]	CYS
1	A	217	ARG
1	A	226	THR
1	A	277	ASN

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Mol	Chain	Res	Type
1	B	72	ASN
1	B	128[A]	CYS
1	B	128[B]	CYS
1	B	153	ASP
1	B	189	GLN
1	B	217	ARG
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	A	51	ASN
1	A	180	ASN
1	B	74	GLN

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 ⓘ

Unable to reproduce the depositors R factor - this section is therefore empty.

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

Unable to reproduce the depositors R factor - this section is therefore empty.

6.3 Carbohydrates ⓘ

Unable to reproduce the depositors R factor - this section is therefore empty.

6.4 Ligands ⓘ

Unable to reproduce the depositors R factor - this section is therefore empty.

6.5 Other polymers ⓘ

Unable to reproduce the depositors R factor - this section is therefore empty.