



Full wwPDB X-ray Structure Validation Report ⓘ

Oct 23, 2023 – 12:12 PM JST

PDB ID : 8H91
Title : Crystal structure of SARS-CoV-2 spike receptor-binding domain in complex with nanobody N19
Authors : Zhang, Y.T.; Li, J.; Zhang, J.
Deposited on : 2022-10-24
Resolution : 3.07 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

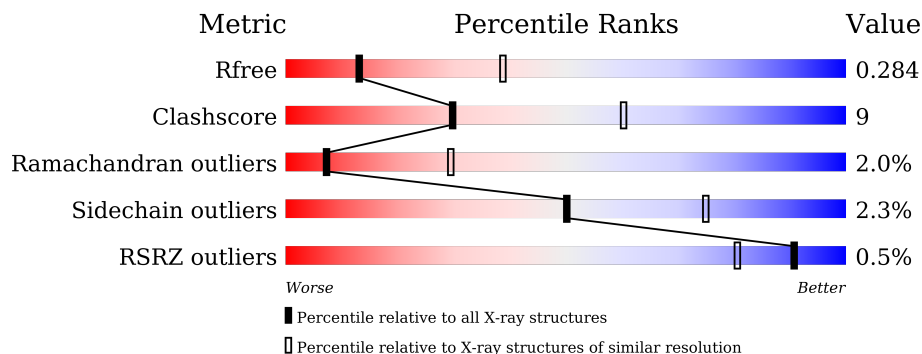
1 Overall quality at a glance

The following experimental techniques were used to determine the structure:

X-RAY DIFFRACTION

The reported resolution of this entry is 3.07 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	1447 (3.10-3.06)
Clashscore	141614	1546 (3.10-3.06)
Ramachandran outliers	138981	1487 (3.10-3.06)
Sidechain outliers	138945	1486 (3.10-3.06)
RSRZ outliers	127900	1416 (3.10-3.06)

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	194	 77% 22% .
1	B	194	 79% 20% .
2	C	117	 69% 26% . .
2	D	117	 3% 74% 24% .

2 Entry composition

There are 2 unique types of molecules in this entry. The entry contains 4728 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 Spike protein S1.

Mol	Chain	Residues	Atoms					ZeroOcc	AltConf	Trace
			Total	C	N	O	S			
1	A	194	1506	965	251	282	8	0	0	0
1	B	194	1493	956	249	280	8	0	0	0

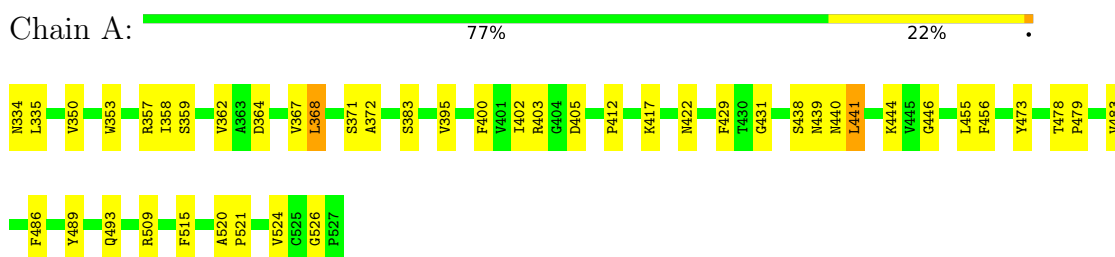
- Molecule 2 is a protein called nanobody.

Mol	Chain	Residues	Atoms					ZeroOcc	AltConf	Trace
			Total	C	N	O	S			
2	C	116	849	530	151	165	3	0	0	0
2	D	117	880	549	156	172	3	0	0	0

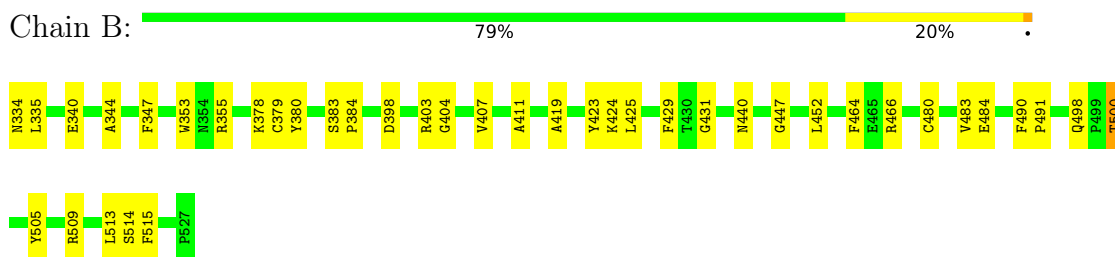
3 Residue-property plots [i](#)

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.

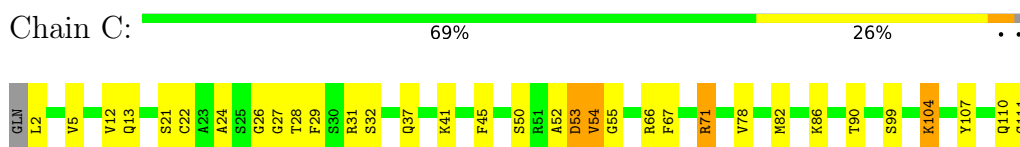
- Molecule 1: Spike protein S1



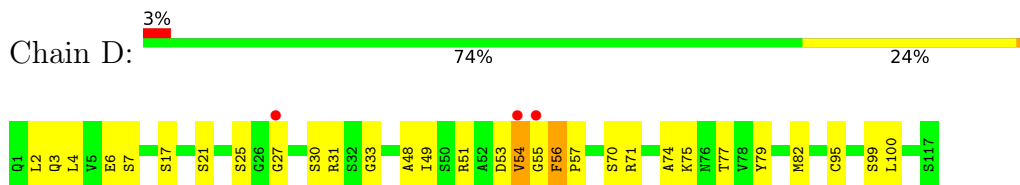
- Molecule 1: Spike protein S1



- Molecule 2: nanobody



- Molecule 2: nanobody



4 Data and refinement statistics

Property	Value	Source
Space group	P 41 21 2	Depositor
Cell constants a, b, c, α , β , γ	57.37Å 57.37Å 444.07Å 90.00° 90.00° 90.00°	Depositor
Resolution (Å)	55.54 – 3.07 55.54 – 3.07	Depositor EDS
% Data completeness (in resolution range)	98.6 (55.54-3.07) 98.6 (55.54-3.07)	Depositor EDS
R_{merge}	0.05	Depositor
R_{sym}	(Not available)	Depositor
$\langle I/\sigma(I) \rangle$ ¹	2.17 (at 3.07Å)	Xtrriage
Refinement program	PHENIX 1.12_2829	Depositor
R, R_{free}	0.212 , 0.284 0.212 , 0.284	Depositor DCC
R_{free} test set	707 reflections (4.76%)	wwPDB-VP
Wilson B-factor (Å ²)	57.3	Xtrriage
Anisotropy	0.577	Xtrriage
Bulk solvent k_{sol} (e/Å ³), B_{sol} (Å ²)	0.35 , 44.2	EDS
L-test for twinning ²	$\langle L \rangle = 0.46$, $\langle L^2 \rangle = 0.29$	Xtrriage
Estimated twinning fraction	No twinning to report.	Xtrriage
F_o, F_c correlation	0.91	EDS
Total number of atoms	4728	wwPDB-VP
Average B, all atoms (Å ²)	43.0	wwPDB-VP

Xtrriage's analysis on translational NCS is as follows: *The largest off-origin peak in the Patterson function is 5.15% 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	0.54	0/1549	0.66	1/2112 (0.0%)
1	B	0.52	0/1535	0.64	0/2097
2	C	0.45	0/866	0.71	0/1174
2	D	0.54	0/897	0.74	1/1212 (0.1%)
All	All	0.52	0/4847	0.68	2/6595 (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	B	0	1

There are no bond length outliers.

All (2) bond angle outliers are listed below:

Mol	Chain	Res	Type	Atoms	Z	Observed($^{\circ}$)	Ideal($^{\circ}$)
1	A	441	LEU	CA-CB-CG	5.82	128.69	115.30
2	D	4	LEU	CA-CB-CG	5.61	128.20	115.30

There are no chirality outliers.

All (1) planarity outliers are listed below:

Mol	Chain	Res	Type	Group
1	B	500	THR	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	1506	0	1397	31	0
1	B	1493	0	1373	20	0
2	C	849	0	794	18	0
2	D	880	0	848	20	0
All	All	4728	0	4412	86	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 9.

All (86) 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)
2:D:2:LEU:HD13	2:D:27:GLY:HA3	1.44	0.97
2:D:2:LEU:CD1	2:D:27:GLY:HA3	2.08	0.83
2:D:31:ARG:NH2	2:D:56:PHE:O	2.17	0.77
1:A:455:LEU:HD12	1:A:493:GLN:HG3	1.67	0.76
1:A:444:LYS:HD3	1:A:446:GLY:H	1.54	0.71
2:D:2:LEU:HD13	2:D:27:GLY:CA	2.19	0.71
1:B:431:GLY:HA2	1:B:515:PHE:CE2	2.27	0.70
2:D:49:ILE:HD11	2:D:54:VAL:HA	1.78	0.65
1:A:357:ARG:NH1	1:A:359:SER:OG	2.29	0.65
1:A:364:ASP:OD1	1:A:367:VAL:N	2.30	0.65
1:A:444:LYS:HD3	1:A:446:GLY:N	2.13	0.62
2:C:37:GLN:NE2	2:C:41:LYS:O	2.33	0.62
1:A:334:ASN:O	1:A:362:VAL:HG12	1.99	0.61
2:D:70:SER:HB2	2:D:79:TYR:HB2	1.85	0.59
2:D:7:SER:HG	2:D:21:SER:HG	1.50	0.58
1:A:412:PRO:HG3	1:A:429:PHE:HB3	1.85	0.58
2:C:52:ALA:O	2:C:54:VAL:N	2.37	0.58
2:D:6:GLU:OE1	2:D:95:CYS:N	2.28	0.56
1:B:404:GLY:O	1:B:407:VAL:HG23	2.06	0.56
2:C:53:ASP:HA	2:C:71:ARG:NH1	2.21	0.55
1:A:362:VAL:HG23	1:A:526:GLY:HA2	1.89	0.55
1:B:379:CYS:HB2	1:B:384:PRO:HG3	1.89	0.55
1:B:480:CYS:O	1:B:483:VAL:HG12	2.08	0.54
1:B:334:ASN:CG	1:B:335:LEU:H	2.10	0.53
1:A:489:TYR:CE1	2:C:104:LYS:HD3	2.44	0.52
1:A:359:SER:HA	1:A:524:VAL:CG2	2.42	0.50
2:C:12:VAL:HG12	2:C:13:GLN:O	2.11	0.50

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Atom-1	Atom-2	Interatomic distance (Å)	Clash overlap (Å)
1:A:368:LEU:O	1:A:371:SER:N	2.33	0.50
1:A:439:ASN:C	1:A:441:LEU:H	2.15	0.50
1:B:490:PHE:CD1	1:B:491:PRO:HD2	2.46	0.50
1:A:455:LEU:HD23	1:A:455:LEU:O	2.11	0.50
2:C:31:ARG:HD2	2:C:50:SER:HB3	1.92	0.50
1:A:439:ASN:O	1:A:441:LEU:N	2.44	0.49
1:B:419:ALA:O	1:B:424:LYS:HD2	2.11	0.49
1:A:483:VAL:HG13	2:C:45:PHE:CD2	2.47	0.49
1:B:355:ARG:NE	1:B:398:ASP:OD1	2.42	0.49
2:D:55:GLY:C	2:D:57:PRO:HD3	2.32	0.49
1:A:350:VAL:O	1:A:353:TRP:HD1	1.96	0.49
1:A:362:VAL:HG23	1:A:526:GLY:CA	2.42	0.48
2:C:90:THR:HG23	2:C:115:THR:HA	1.95	0.48
2:C:53:ASP:O	2:C:55:GLY:N	2.47	0.48
1:A:371:SER:OG	1:A:372:ALA:N	2.46	0.48
2:D:75:LYS:O	2:D:77:THR:HG23	2.13	0.48
2:D:51:ARG:HD2	2:D:71:ARG:CZ	2.44	0.47
2:C:2:LEU:HD23	2:C:107:TYR:CG	2.50	0.47
1:B:484:GLU:OE1	2:D:31:ARG:HD3	2.14	0.47
1:A:456:PHE:HB3	1:A:473:TYR:CG	2.49	0.46
1:B:411:ALA:N	1:B:425:LEU:HD12	2.30	0.46
1:A:400:PHE:HE1	1:A:402:ILE:HD13	1.81	0.46
1:A:417:LYS:HD3	1:A:417:LYS:HA	1.73	0.46
2:D:53:ASP:C	2:D:55:GLY:H	2.19	0.46
1:B:340:GLU:O	1:B:344:ALA:HB2	2.15	0.45
2:D:56:PHE:N	2:D:57:PRO:HD3	2.31	0.45
1:B:347:PHE:CD2	1:B:509:ARG:HG2	2.51	0.45
2:C:13:GLN:HA	2:C:117:SER:OG	2.16	0.45
1:B:447:GLY:HA2	1:B:498:GLN:HG2	1.98	0.45
2:C:31:ARG:HA	2:C:50:SER:HA	1.98	0.45
1:A:403:ARG:NH1	1:A:405:ASP:HB2	2.32	0.45
2:C:32:SER:OG	2:C:78:VAL:HG21	2.17	0.44
1:A:350:VAL:HG22	1:A:422:ASN:HB3	1.99	0.44
1:A:431:GLY:HA2	1:A:515:PHE:CE2	2.53	0.44
1:B:334:ASN:CG	1:B:335:LEU:N	2.71	0.44
1:A:438:SER:HB3	1:A:509:ARG:HG3	1.99	0.43
2:C:5:VAL:O	2:C:22:CYS:HA	2.18	0.43
2:C:110:GLN:HG2	2:C:111:GLY:N	2.31	0.43
1:A:520:ALA:HB1	1:A:521:PRO:HD2	2.00	0.43
1:B:429:PHE:HE1	1:B:514:SER:HB3	1.84	0.43
2:D:53:ASP:C	2:D:55:GLY:N	2.72	0.43

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Atom-1	Atom-2	Interatomic distance (Å)	Clash overlap (Å)
1:B:403:ARG:HG2	1:B:505:TYR:HA	2.00	0.43
1:B:431:GLY:HA3	1:B:513:LEU:O	2.18	0.43
2:C:66:ARG:CZ	2:C:86:LYS:HE2	2.48	0.43
2:D:17:SER:HA	2:D:82:MET:O	2.19	0.43
2:D:100:LEU:HD23	2:D:100:LEU:HA	1.85	0.42
1:B:419:ALA:HA	1:B:423:TYR:O	2.20	0.42
2:D:3:GLN:HB3	2:D:25:SER:OG	2.20	0.42
1:A:478:THR:HG22	1:A:479:PRO:O	2.19	0.42
2:C:24:ALA:C	2:C:26:GLY:HA2	2.40	0.41
1:A:334:ASN:CG	1:A:335:LEU:N	2.74	0.41
1:A:358:ILE:HB	1:A:395:VAL:HB	2.02	0.41
1:A:403:ARG:HH12	1:A:405:ASP:HB2	1.86	0.41
1:B:378:LYS:HD3	1:B:380:TYR:OH	2.21	0.41
2:C:67:PHE:CD1	2:C:82:MET:HA	2.56	0.41
1:A:335:LEU:HD12	1:A:362:VAL:HG13	2.03	0.40
2:D:33:GLY:HA2	2:D:48:ALA:HA	2.02	0.40
2:D:51:ARG:HD2	2:D:71:ARG:NH2	2.36	0.40
1:B:353:TRP:CZ2	1:B:466:ARG:HB2	2.56	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	192/194 (99%)	170 (88%)	20 (10%)	2 (1%)	15	47
1	B	192/194 (99%)	167 (87%)	22 (12%)	3 (2%)	9	35
2	C	114/117 (97%)	101 (89%)	8 (7%)	5 (4%)	2	14
2	D	115/117 (98%)	101 (88%)	12 (10%)	2 (2%)	9	34
All	All	613/622 (99%)	539 (88%)	62 (10%)	12 (2%)	7	29

All (12) Ramachandran outliers are listed below:

Mol	Chain	Res	Type
2	C	29	PHE
1	A	368	LEU
1	B	500	THR
1	A	440	ASN
2	C	53	ASP
1	B	440	ASN
2	C	54	VAL
2	C	27	GLY
2	C	28	THR
2	D	54	VAL
2	D	74	ALA
1	B	464	PHE

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	159/167 (95%)	157 (99%)	2 (1%)	69	86
1	B	156/167 (93%)	154 (99%)	2 (1%)	69	86
2	C	83/91 (91%)	79 (95%)	4 (5%)	25	57
2	D	90/91 (99%)	87 (97%)	3 (3%)	38	68
All	All	488/516 (95%)	477 (98%)	11 (2%)	50	75

All (11) residues with a non-rotameric sidechain are listed below:

Mol	Chain	Res	Type
1	A	383	SER
1	A	486	PHE
1	B	383	SER
1	B	452	LEU
2	C	21	SER
2	C	71	ARG
2	C	99	SER
2	C	104	LYS
2	D	30	SER
2	D	56	PHE

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Mol	Chain	Res	Type
2	D	99	SER

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	493	GLN
1	B	334	ASN
1	B	388	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 monosaccharides 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 [i](#)

6.1 Protein, DNA and RNA chains [i](#)

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	194/194 (100%)	-0.39	0 100 100	27, 41, 58, 76	0
1	B	194/194 (100%)	-0.35	0 100 100	31, 42, 68, 75	0
2	C	116/117 (99%)	-0.25	0 100 100	32, 42, 54, 60	0
2	D	117/117 (100%)	-0.05	3 (2%) 56 31	32, 42, 63, 78	0
All	All	621/622 (99%)	-0.29	3 (0%) 91 80	27, 42, 63, 78	0

All (3) RSRZ outliers are listed below:

Mol	Chain	Res	Type	RSRZ
2	D	55	GLY	4.8
2	D	54	VAL	4.1
2	D	27	GLY	3.0

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.