



# Full wwPDB X-ray Structure Validation Report ⓘ

Nov 20, 2023 – 01:04 AM JST

PDB ID : 7CDZ  
Title : Crystal structure of 2019-nCoV nucleocapsid N-terminal domain (NTD) protein  
Authors : Peng, Y.; Song, H.; Qi, J.; Gao, G.F.  
Deposited on : 2020-06-21  
Resolution : 1.80 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](mailto: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

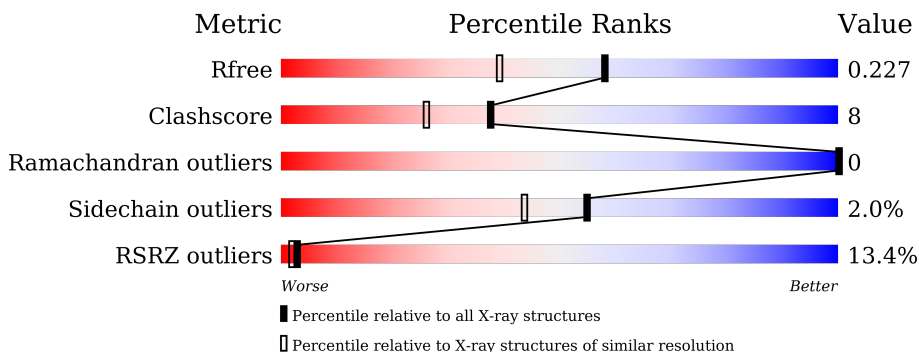
# 1 Overall quality at a glance

The following experimental techniques were used to determine the structure:

*X-RAY DIFFRACTION*

The reported resolution of this entry is 1.80 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	5950 (1.80-1.80)
Clashscore	141614	6793 (1.80-1.80)
Ramachandran outliers	138981	6697 (1.80-1.80)
Sidechain outliers	138945	6696 (1.80-1.80)
RSRZ outliers	127900	5850 (1.80-1.80)

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  $\geq 3$ , 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	137	
1	B	137	
1	C	137	
1	D	137	

## 2 Entry composition i

There are 2 unique types of molecules in this entry. The entry contains 4567 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 Nucleoprotein.

Mol	Chain	Residues	Atoms					ZeroOcc	AltConf	Trace
			Total	C	N	O	S			
1	A	128	998	630	180	187	1	0	0	0
1	B	127	988	625	179	183	1	0	0	0
1	C	126	980	621	177	181	1	0	0	0
1	D	127	990	626	178	185	1	0	0	0

There are 24 discrepancies between the modelled and reference sequences:

Chain	Residue	Modelled	Actual	Comment	Reference
A	-5	HIS	-	expression tag	UNP P0DTC9
A	-4	HIS	-	expression tag	UNP P0DTC9
A	-3	HIS	-	expression tag	UNP P0DTC9
A	-2	HIS	-	expression tag	UNP P0DTC9
A	-1	HIS	-	expression tag	UNP P0DTC9
A	0	HIS	-	expression tag	UNP P0DTC9
B	-5	HIS	-	expression tag	UNP P0DTC9
B	-4	HIS	-	expression tag	UNP P0DTC9
B	-3	HIS	-	expression tag	UNP P0DTC9
B	-2	HIS	-	expression tag	UNP P0DTC9
B	-1	HIS	-	expression tag	UNP P0DTC9
B	0	HIS	-	expression tag	UNP P0DTC9
C	-5	HIS	-	expression tag	UNP P0DTC9
C	-4	HIS	-	expression tag	UNP P0DTC9
C	-3	HIS	-	expression tag	UNP P0DTC9
C	-2	HIS	-	expression tag	UNP P0DTC9
C	-1	HIS	-	expression tag	UNP P0DTC9
C	0	HIS	-	expression tag	UNP P0DTC9
D	-5	HIS	-	expression tag	UNP P0DTC9
D	-4	HIS	-	expression tag	UNP P0DTC9
D	-3	HIS	-	expression tag	UNP P0DTC9

*Continued on next page...*

*Continued from previous page...*

Chain	Residue	Modelled	Actual	Comment	Reference
D	-2	HIS	-	expression tag	UNP P0DTC9
D	-1	HIS	-	expression tag	UNP P0DTC9
D	0	HIS	-	expression tag	UNP P0DTC9

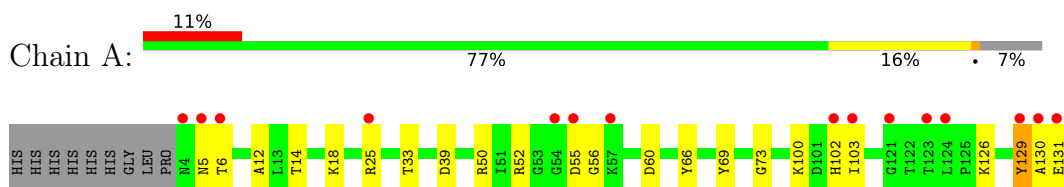
- Molecule 2 is water.

Mol	Chain	Residues	Atoms		ZeroOcc	AltConf
2	A	172	Total 172	O 172	0	0
2	B	166	Total 166	O 166	0	0
2	C	106	Total 106	O 106	0	0
2	D	167	Total 167	O 167	0	0

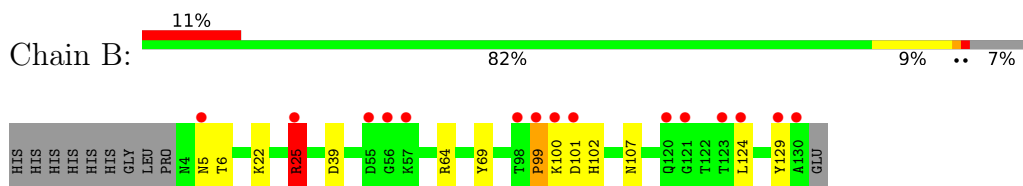
### 3 Residue-property plots [i](#)

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.

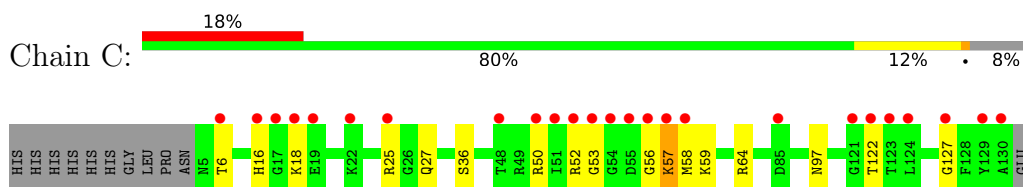
- Molecule 1: Nucleoprotein



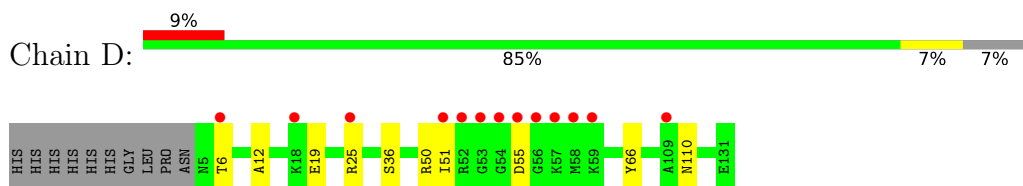
- Molecule 1: Nucleoprotein



- Molecule 1: Nucleoprotein



- Molecule 1: Nucleoprotein



## 4 Data and refinement statistics

Property	Value	Source
Space group	P 1 21 1	Depositor
Cell constants a, b, c, $\alpha$ , $\beta$ , $\gamma$	59.27Å 55.43Å 85.68Å 90.00° 95.38° 90.00°	Depositor
Resolution (Å)	29.50 – 1.80 29.50 – 1.80	Depositor EDS
% Data completeness (in resolution range)	91.0 (29.50-1.80) 91.0 (29.50-1.80)	Depositor EDS
$R_{merge}$	(Not available)	Depositor
$R_{sym}$	(Not available)	Depositor
$\langle I/\sigma(I) \rangle$ <sup>1</sup>	3.12 (at 1.80Å)	Xtrriage
Refinement program	PHENIX 1.15.2_3472	Depositor
R, $R_{free}$	0.197 , 0.227 0.197 , 0.227	Depositor DCC
$R_{free}$ test set	2265 reflections (4.85%)	wwPDB-VP
Wilson B-factor (Å <sup>2</sup> )	18.9	Xtrriage
Anisotropy	0.068	Xtrriage
Bulk solvent $k_{sol}$ (e/Å <sup>3</sup> ), $B_{sol}$ (Å <sup>2</sup> )	0.31 , 43.1	EDS
L-test for twinning <sup>2</sup>	$\langle  L  \rangle = 0.49$ , $\langle L^2 \rangle = 0.32$	Xtrriage
Estimated twinning fraction	No twinning to report.	Xtrriage
$F_o, F_c$ correlation	0.94	EDS
Total number of atoms	4567	wwPDB-VP
Average B, all atoms (Å <sup>2</sup> )	29.0	wwPDB-VP

Xtrriage's analysis on translational NCS is as follows: *The analyses of the Patterson function reveals a significant off-origin peak that is 30.07 % 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 1.3919e-03. The detected translational NCS is most likely also responsible for the elevated intensity ratio.*

<sup>1</sup>Intensities estimated from amplitudes.

<sup>2</sup>Theoretical 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	0.33	0/1026	0.53	0/1394
1	B	0.36	0/1016	0.62	2/1382 (0.1%)
1	C	0.31	0/1008	0.52	0/1371
1	D	0.29	0/1018	0.49	0/1383
All	All	0.32	0/4068	0.54	2/5530 (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	B	25	ARG	CA-CB-CG	6.31	127.29	113.40
1	B	124	LEU	CA-CB-CG	5.94	128.96	115.30

There are no chirality outliers.

All (1) planarity outliers are listed below:

Mol	Chain	Res	Type	Group
1	B	99	PRO	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	998	0	965	25	0
1	B	988	0	959	16	3
1	C	980	0	953	16	2
1	D	990	0	959	10	0
2	A	172	0	0	6	2
2	B	166	0	0	5	0
2	C	106	0	0	4	1
2	D	167	0	0	3	0
All	All	4567	0	3836	60	5

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 8.

All (60) 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:99:PRO:HB2	1:B:101:ASP:H	1.22	1.01
1:A:5:ASN:HB3	1:C:97:ASN:HD22	1.36	0.90
1:A:39:ASP:OD1	1:A:102:HIS:NE2	2.07	0.88
1:A:129:TYR:OH	1:B:129:TYR:CZ	2.31	0.84
1:B:6:THR:O	2:B:202:HOH:O	1.98	0.82
1:A:130:ALA:O	2:A:201:HOH:O	1.99	0.80
1:A:6:THR:N	2:A:202:HOH:O	2.15	0.79
1:B:99:PRO:CG	1:B:101:ASP:OD1	2.32	0.77
1:D:55:ASP:OD1	2:D:201:HOH:O	2.05	0.72
1:B:99:PRO:CB	1:B:101:ASP:OD1	2.39	0.71
1:A:129:TYR:HD1	1:A:129:TYR:O	1.73	0.70
1:B:99:PRO:HG3	1:B:101:ASP:OD1	1.91	0.70
1:B:99:PRO:HB2	1:B:101:ASP:N	2.03	0.69
1:A:52:ARG:NH2	1:A:56:GLY:O	2.27	0.68
1:A:131:GLU:OE1	1:B:64:ARG:NH1	2.21	0.65
1:C:64:ARG:NH1	2:C:204:HOH:O	2.31	0.64
1:A:129:TYR:O	1:A:129:TYR:CD1	2.55	0.59
2:A:210:HOH:O	1:D:6:THR:HG21	2.02	0.59
1:A:18:LYS:H	1:A:126:LYS:NZ	2.01	0.58
1:B:39:ASP:HA	1:B:100:LYS:HD2	1.86	0.57
1:A:6:THR:HG23	1:A:73:GLY:HA2	1.85	0.57
1:A:50:ARG:NH2	1:A:60:ASP:OD1	2.37	0.57
1:C:50:ARG:O	1:C:50:ARG:HD2	2.05	0.56

*Continued on next page...*



*Continued from previous page...*

Atom-1	Atom-2	Interatomic distance (Å)	Clash overlap (Å)
1:B:22:LYS:NZ	2:B:203:HOH:O	2.12	0.56
1:D:51:ILE:HA	2:D:206:HOH:O	2.05	0.56
1:B:99:PRO:HB2	1:B:101:ASP:OD1	2.06	0.55
1:C:27:GLN:HB3	1:C:122:THR:HG23	1.90	0.54
1:A:14:THR:H	1:A:130:ALA:HB2	1.72	0.54
1:D:19:GLU:OE2	2:D:202:HOH:O	2.19	0.52
1:A:131:GLU:HB2	2:A:216:HOH:O	2.08	0.52
1:A:39:ASP:HA	1:A:100:LYS:HE3	1.91	0.51
1:C:6:THR:O	2:C:201:HOH:O	2.18	0.51
1:A:6:THR:CA	2:A:202:HOH:O	2.57	0.49
1:C:53:GLY:HA3	1:C:59:LYS:HD3	1.95	0.47
1:B:5:ASN:HB3	1:B:107:ASN:HB2	1.96	0.47
1:D:12:ALA:HB2	1:D:66:TYR:CE1	2.50	0.47
1:A:12:ALA:HB2	1:A:66:TYR:CE1	2.50	0.47
1:B:102:HIS:HB3	2:B:246:HOH:O	2.13	0.46
1:C:57:LYS:HD2	1:C:58:MET:O	2.16	0.46
1:A:5:ASN:CB	1:C:97:ASN:HD22	2.19	0.46
1:A:55:ASP:OD2	1:A:55:ASP:N	2.50	0.45
1:C:6:THR:HG22	2:C:201:HOH:O	2.16	0.45
2:B:233:HOH:O	1:C:6:THR:HG21	2.15	0.45
1:A:69:TYR:CE2	1:A:103:ILE:HG21	2.51	0.45
1:A:5:ASN:HB3	1:C:97:ASN:ND2	2.18	0.44
1:A:33:THR:HB	1:D:110:ASN:HD21	1.82	0.44
1:B:69:TYR:HB3	1:B:100:LYS:HB2	2.00	0.44
1:C:52:ARG:NH1	1:C:56:GLY:O	2.49	0.44
1:C:50:ARG:HA	1:C:59:LYS:O	2.17	0.44
2:A:306:HOH:O	1:D:6:THR:HG23	2.18	0.43
1:C:57:LYS:HE3	1:C:59:LYS:HB3	2.01	0.43
1:D:50:ARG:O	1:D:51:ILE:HD13	2.20	0.42
2:B:222:HOH:O	1:D:36:SER:HB2	2.20	0.42
1:D:55:ASP:OD1	1:D:55:ASP:N	2.52	0.42
1:A:129:TYR:OH	1:B:129:TYR:OH	2.38	0.42
1:C:64:ARG:CZ	2:C:204:HOH:O	2.67	0.41
1:A:69:TYR:CE1	1:A:103:ILE:HD12	2.55	0.41
1:A:18:LYS:H	1:A:126:LYS:HZ1	1.65	0.41
1:B:99:PRO:HB2	1:B:101:ASP:CB	2.51	0.41
1:C:16:HIS:N	1:C:127:GLY:O	2.43	0.41

All (5) 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)
1:B:99:PRO:N	1:C:50:ARG:NH1[2_545]	1.72	0.48
1:B:25:ARG:NH2	1:B:102:HIS:O[2_545]	1.75	0.45
2:A:332:HOH:O	2:C:270:HOH:O[2_546]	2.07	0.13
1:B:99:PRO:CA	1:C:50:ARG:NH1[2_545]	2.15	0.05
2:A:311:HOH:O	2:A:313:HOH:O[2_646]	2.17	0.03

### 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	126/137 (92%)	126 (100%)	0	0	100	100
1	B	125/137 (91%)	124 (99%)	1 (1%)	0	100	100
1	C	124/137 (90%)	122 (98%)	2 (2%)	0	100	100
1	D	125/137 (91%)	125 (100%)	0	0	100	100
All	All	500/548 (91%)	497 (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	101/109 (93%)	99 (98%)	2 (2%)	55	44
1	B	100/109 (92%)	99 (99%)	1 (1%)	76	71
1	C	99/109 (91%)	95 (96%)	4 (4%)	31	16

*Continued on next page...*

*Continued from previous page...*

Mol	Chain	Analysed	Rotameric	Outliers	Percentiles	
1	D	100/109 (92%)	99 (99%)	1 (1%)	76	71
All	All	400/436 (92%)	392 (98%)	8 (2%)	55	44

All (8) residues with a non-rotameric sidechain are listed below:

Mol	Chain	Res	Type
1	A	25	ARG
1	A	129	TYR
1	B	25	ARG
1	C	18	LYS
1	C	25	ARG
1	C	36	SER
1	C	57	LYS
1	D	25	ARG

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

Mol	Chain	Res	Type
1	C	5	ASN
1	C	97	ASN
1	D	110	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

### 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<sup>th</sup> 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 <sup>2</sup> )	Q<0.9
1	A	128/137 (93%)	0.57	15 (11%) 4 3	10, 24, 58, 98	0
1	B	127/137 (92%)	0.48	15 (11%) 4 3	9, 19, 58, 106	0
1	C	126/137 (91%)	0.83	25 (19%) 1 0	12, 30, 83, 118	0
1	D	127/137 (92%)	0.44	13 (10%) 6 5	8, 21, 67, 101	0
All	All	508/548 (92%)	0.58	68 (13%) 3 2	8, 23, 70, 118	0

All (68) RSRZ outliers are listed below:

Mol	Chain	Res	Type	RSRZ
1	B	130	ALA	10.1
1	D	53	GLY	10.1
1	B	99	PRO	9.7
1	D	55	ASP	6.9
1	D	54	GLY	6.8
1	C	123	THR	6.7
1	A	129	TYR	6.7
1	A	130	ALA	6.0
1	D	57	LYS	5.6
1	C	57	LYS	5.4
1	A	102	HIS	5.3
1	A	6	THR	5.2
1	A	4	ASN	5.1
1	C	53	GLY	4.9
1	C	129	TYR	4.6
1	C	55	ASP	4.5
1	C	51	ILE	4.5
1	B	129	TYR	4.4
1	C	6	THR	4.2
1	B	124	LEU	4.1
1	C	122	THR	4.1

*Continued on next page...*

*Continued from previous page...*

<b>Mol</b>	<b>Chain</b>	<b>Res</b>	<b>Type</b>	<b>RSRZ</b>
1	C	124	LEU	4.0
1	A	25	ARG	3.9
1	B	101	ASP	3.8
1	A	131	GLU	3.8
1	C	56	GLY	3.8
1	A	103	ILE	3.6
1	D	52	ARG	3.5
1	A	5	ASN	3.5
1	D	51	ILE	3.4
1	C	58	MET	3.3
1	D	56	GLY	3.3
1	D	58	MET	3.3
1	C	18	LYS	3.2
1	D	18	LYS	3.1
1	A	121	GLY	3.1
1	A	54	GLY	3.1
1	B	55	ASP	3.0
1	B	123	THR	2.9
1	A	124	LEU	2.9
1	C	16	HIS	2.8
1	A	123	THR	2.7
1	C	17	GLY	2.7
1	D	6	THR	2.7
1	B	57	LYS	2.6
1	B	25	ARG	2.6
1	C	121	GLY	2.6
1	B	5	ASN	2.5
1	C	85	ASP	2.5
1	D	59	LYS	2.5
1	C	130	ALA	2.5
1	B	98	THR	2.5
1	A	57	LYS	2.4
1	A	55	ASP	2.4
1	C	54	GLY	2.4
1	C	50	ARG	2.3
1	B	120	GLN	2.3
1	C	19	GLU	2.3
1	B	56	GLY	2.2
1	C	52	ARG	2.2
1	C	48	THR	2.2
1	C	25	ARG	2.1
1	D	109	ALA	2.1

*Continued on next page...*

*Continued from previous page...*

Mol	Chain	Res	Type	RSRZ
1	B	100	LYS	2.1
1	D	25	ARG	2.1
1	C	22	LYS	2.1
1	B	121	GLY	2.1
1	C	127	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.