Full wwPDB X-ray Structure Validation Report (i)

Nov 20, 2023 – 08:33 PM JST

PDB ID	:	7DET
Title	:	Crystal structure of SARS-CoV-2 RBD in complex with a neutralizing antibody scFv
Authors	:	Wang, Y.; Zhang, G.; Li, X.; Rao, Z.; Guo, Y.
Deposited on	:	2020-11-05
Resolution	:	2.20 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 (i) 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 (i)) were used in the production of this report:

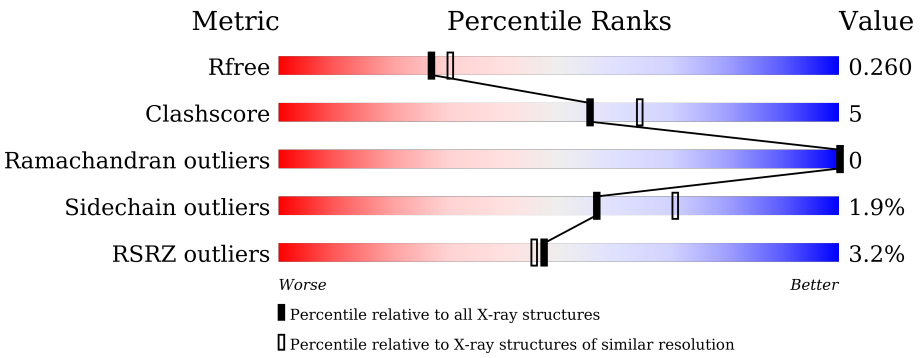
MolProbity	:	4.02b-467
Mogul	:	1.8.5 (274361), CSD as541be (2020)
Xtriage (Phenix)	:	1.13
EDS	:	2.36
Percentile statistics	:	20191225.v01 (using entries in the PDB archive December 25th 2019)
Refmac	:	5.8.0158
CCP4	:	7.0.044 (Gargrove)
Ideal geometry (proteins)	:	Engh & Huber (2001)
Ideal geometry (DNA, 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 2.20 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	4898 (2.20-2.20)
Clashscore	141614	5594 (2.20-2.20)
Ramachandran outliers	138981	5503 (2.20-2.20)
Sidechain outliers	138945	5504 (2.20-2.20)
RSRZ outliers	127900	4800 (2.20-2.20)

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	206	.% 86% 7% 6%
1	C	206	8% 77% 17% 6%
2	B	280	2% 69% 14% 18%
2	D	280	71% 11% • 18%

2 Entry composition (i)

There are 4 unique types of molecules in this entry. The entry contains 6998 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	193	1528	981	254	285	8	0	0	0
1	C	194	1536	985	256	287	8	0	0	0

There are 18 discrepancies between the modelled and reference sequences:

Chain	Residue	Modelled	Actual	Comment	Reference
A	531	ALA	-	expression tag	UNP P0DTC2
A	532	ALA	-	expression tag	UNP P0DTC2
A	533	ALA	-	expression tag	UNP P0DTC2
A	534	HIS	-	expression tag	UNP P0DTC2
A	535	HIS	-	expression tag	UNP P0DTC2
A	536	HIS	-	expression tag	UNP P0DTC2
A	537	HIS	-	expression tag	UNP P0DTC2
A	538	HIS	-	expression tag	UNP P0DTC2
A	539	HIS	-	expression tag	UNP P0DTC2
C	531	ALA	-	expression tag	UNP P0DTC2
C	532	ALA	-	expression tag	UNP P0DTC2
C	533	ALA	-	expression tag	UNP P0DTC2
C	534	HIS	-	expression tag	UNP P0DTC2
C	535	HIS	-	expression tag	UNP P0DTC2
C	536	HIS	-	expression tag	UNP P0DTC2
C	537	HIS	-	expression tag	UNP P0DTC2
C	538	HIS	-	expression tag	UNP P0DTC2
C	539	HIS	-	expression tag	UNP P0DTC2

- Molecule 2 is a protein called antibody scFv.

Mol	Chain	Residues	Atoms					ZeroOcc	AltConf	Trace
			Total	C	N	O	S			
2	B	231	1797	1130	305	355	7	0	0	0

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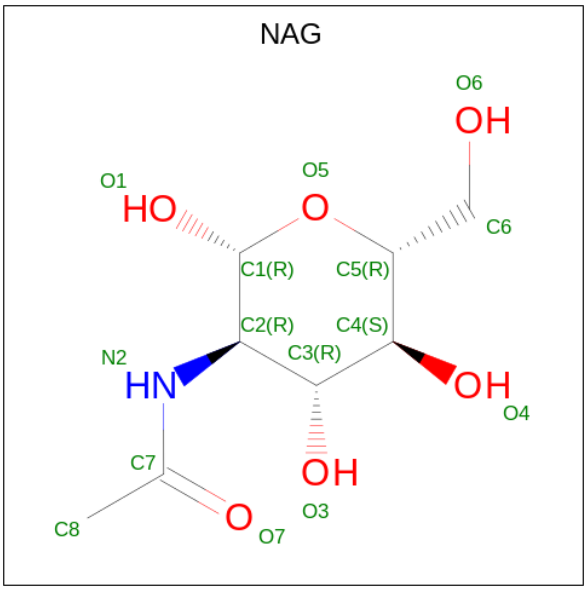
Mol	Chain	Residues	Atoms					ZeroOcc	AltConf	Trace
			Total	C	N	O	S			
2	D	231	1797	1130	305	355	7	0	0	0

- Molecule 3 is 2-acetamido-2-deoxy-beta-D-glucopyranose (three-letter code: NAG) (formula: $C_8H_{15}NO_6$).



Mol	Chain	Residues	Atoms				ZeroOcc	AltConf
			Total	C	N	O		
3	A	1	14	8	1	5	0	0
3	C	1	14	8	1	5	0	0

- Molecule 4 is water.

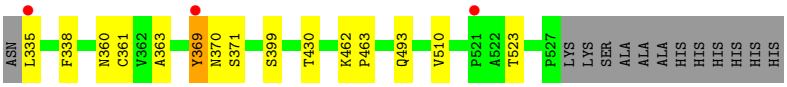
Mol	Chain	Residues	Atoms		ZeroOcc	AltConf
			Total	O		
4	A	90	90	90	0	0
4	B	78	78	78	0	0
4	C	43	43	43	0	0
4	D	101	101	101	0	0

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.

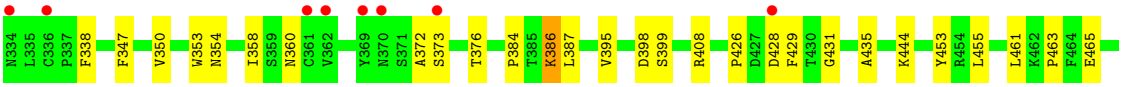
• Molecule 1: Spike protein S1

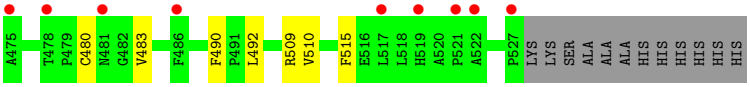
Chain A:



• Molecule 1: Spike protein S1

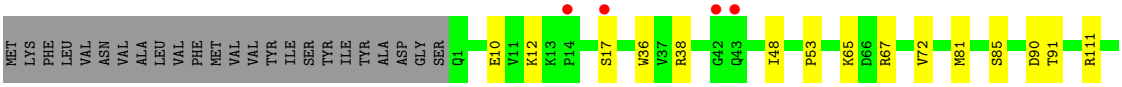
Chain C:

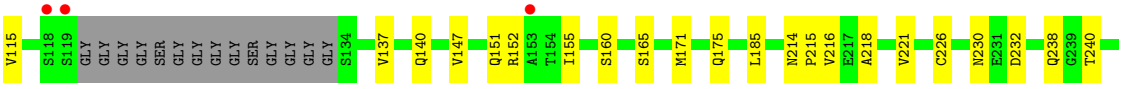




• Molecule 2: antibody scFv

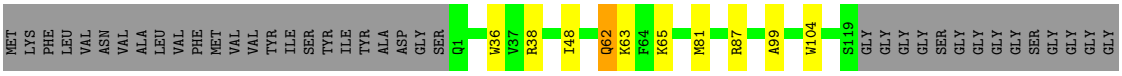
Chain B:

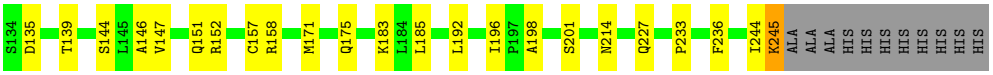




• Molecule 2: antibody scFv

Chain D:




S134
D135
T139
S144
L145
A146
V147
Q151
R152
C157
R158
M171
Q175
K183
L184
L185
L192
I196
P197
A198
S201
N214
Q227
P233
F236
I244
K245
ALA
ALA
ALA
HIS
HIS
HIS
HIS
HIS
HIS
HIS
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HIS

4 Data and refinement statistics (i)

Property	Value	Source
Space group	P 1 21 1	Depositor
Cell constants a, b, c, α, β, γ	94.97Å 42.25Å 104.41Å 90.00° 104.57° 90.00°	Depositor
Resolution (Å)	46.47 – 2.20 46.47 – 2.20	Depositor EDS
% Data completeness (in resolution range)	94.1 (46.47-2.20) 94.1 (46.47-2.20)	Depositor EDS
R_{merge}	0.11	Depositor
R_{sym}	(Not available)	Depositor
$< I/\sigma(I) >$ [1]	2.23 (at 2.20Å)	Xtriage
Refinement program	PHENIX 1.14_3228	Depositor
R, R_{free}	0.212 , 0.260 0.212 , 0.260	Depositor DCC
R_{free} test set	1993 reflections (5.11%)	wwPDB-VP
Wilson B-factor (Å^2)	32.0	Xtriage
Anisotropy	0.102	Xtriage
Bulk solvent k_{sol}(e/Å^3), B_{sol}(Å^2)	0.32 , 40.8	EDS
L-test for twinning[2]	$< \|L\| > = 0.49$, $< L^2 > = 0.31$	Xtriage
Estimated twinning fraction	No twinning to report.	Xtriage
F_o,F_c correlation	0.93	EDS
Total number of atoms	6998	wwPDB-VP
Average B, all atoms (Å^2)	34.0	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 27.42 % 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 2.2071e-03. 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 (i)

5.1 Standard geometry (i)

Bond lengths and bond angles in the following residue types are not validated in this section: NAG

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	0/1572	0.51	0/2140
1	C	0.29	0/1580	0.50	0/2151
2	B	0.32	0/1841	0.51	0/2503
2	D	0.31	0/1841	0.51	0/2503
All	All	0.31	0/6834	0.51	0/9297

There are no bond length outliers.

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	1528	0	1446	8	0
1	C	1536	0	1452	21	0
2	B	1797	0	1721	22	0
2	D	1797	0	1721	16	0
3	A	14	0	13	0	0
3	C	14	0	13	0	0
4	A	90	0	0	1	0
4	B	78	0	0	1	0
4	C	43	0	0	3	0

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Mol	Chain	Non-H	H(model)	H(added)	Clashes	Symm-Clashes
4	D	101	0	0	0	0
All	All	6998	0	6366	67	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 5.

All (67) 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:B:111:ARG:NH2	4:B:301:HOH:O	2.20	0.75
2:B:175:GLN:HB2	2:B:185:LEU:HD11	1.71	0.71
2:D:192:LEU:HD11	2:D:198:ALA:HA	1.79	0.64
1:A:335:LEU:HD23	1:A:361:CYS:HA	1.79	0.64
2:B:147:VAL:HG11	2:B:216:VAL:HG21	1.83	0.61
1:C:376:THR:HB	1:C:435:ALA:HB3	1.88	0.56
2:D:36:TRP:CE2	2:D:81:MET:HB2	2.43	0.53
1:C:444:LYS:NZ	4:C:707:HOH:O	2.40	0.53
1:C:453:TYR:HE2	1:C:455:LEU:HD13	1.72	0.53
1:C:408:ARG:HG3	4:C:710:HOH:O	2.10	0.52
2:D:157:CYS:SG	2:D:171:MET:HE1	2.50	0.52
2:D:139:THR:HB	2:D:158:ARG:HB3	1.93	0.51
2:B:140:GLN:H	2:B:238:GLN:HE22	1.58	0.50
1:C:426:PRO:HB3	1:C:463:PRO:HB3	1.93	0.50
2:D:135:ASP:OD1	2:D:233:PRO:CD	2.61	0.49
2:B:147:VAL:O	2:B:244:ILE:HA	2.14	0.48
1:C:384:PRO:HA	1:C:387:LEU:HD12	1.95	0.47
1:C:480:CYS:O	1:C:483:VAL:HG12	2.14	0.47
1:C:338:PHE:HE1	1:C:358:ILE:HD13	1.79	0.47
1:C:373:SER:HB3	4:C:711:HOH:O	2.14	0.47
2:B:218:ALA:O	2:B:221:VAL:HG12	2.15	0.46
2:B:10:GLU:HB3	2:B:12:LYS:HZ2	1.80	0.46
1:C:372:ALA:O	1:C:373:SER:HB2	2.15	0.46
2:D:152:ARG:HG3	2:D:214:ASN:HB2	1.98	0.46
1:A:338:PHE:HE2	1:A:363:ALA:HB1	1.81	0.45
1:C:399:SER:HA	1:C:510:VAL:O	2.16	0.45
2:B:36:TRP:CE2	2:B:81:MET:HB2	2.52	0.45
2:D:38:ARG:HB3	2:D:48:ILE:HD11	1.99	0.45
1:C:347:PHE:CD2	1:C:509:ARG:HG2	2.52	0.45
1:C:461:LEU:HB3	1:C:465:GLU:HB3	1.98	0.45
2:B:53:PRO:HA	2:B:72:VAL:HG21	1.99	0.44
2:B:12:LYS:HD2	2:B:17:SER:O	2.18	0.44

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Atom-1	Atom-2	Interatomic distance (Å)	Clash overlap (Å)
1:A:369:TYR:O	1:A:371:SER:N	2.43	0.44
2:D:62:GLN:HB2	2:D:65:LYS:CE	2.48	0.44
2:B:165:SER:HB2	2:B:230:ASN:OD1	2.18	0.43
2:B:155:ILE:HG12	2:B:240:THR:HG21	2.01	0.43
1:C:431:GLY:HA2	1:C:515:PHE:CD2	2.53	0.43
2:D:147:VAL:O	2:D:244:ILE:HA	2.17	0.43
2:B:91:THR:HA	2:B:115:VAL:O	2.18	0.43
1:C:354:ASN:O	1:C:398:ASP:HA	2.19	0.43
1:C:426:PRO:HB2	1:C:428:ASP:OD1	2.19	0.43
1:A:360:ASN:HA	1:A:523:THR:HB	2.00	0.42
2:D:147:VAL:HG22	2:D:151:GLN:HB2	2.01	0.42
2:D:227:GLN:HB2	2:D:236:PHE:CD2	2.54	0.42
2:B:10:GLU:OE1	2:B:12:LYS:NZ	2.51	0.42
2:D:183:LYS:HD3	2:D:196:ILE:HD11	2.00	0.42
2:B:171:MET:HE1	2:B:226:CYS:HB2	2.01	0.42
2:D:146:ALA:HB1	2:D:245:LYS:HD3	2.00	0.42
2:D:175:GLN:HB2	2:D:185:LEU:HD11	2.01	0.42
1:A:462:LYS:HB2	1:A:463:PRO:CD	2.49	0.42
1:A:399:SER:HA	1:A:510:VAL:O	2.20	0.42
1:C:395:VAL:HG22	1:C:515:PHE:HD1	1.85	0.42
1:A:430:THR:O	4:A:701:HOH:O	2.22	0.42
2:B:137:VAL:HB	2:B:160:SER:OG	2.20	0.41
2:D:99:ALA:HB1	2:D:104:TRP:HA	2.02	0.41
2:D:245:LYS:HA	2:D:245:LYS:HD2	1.82	0.41
2:B:214:ASN:HA	2:B:215:PRO:HA	1.80	0.41
2:B:67:ARG:NH1	2:B:90:ASP:OD1	2.41	0.41
1:C:350:VAL:O	1:C:353:TRP:HD1	2.04	0.41
2:B:85:SER:O	2:B:85:SER:OG	2.37	0.41
1:C:490:PHE:CE2	1:C:492:LEU:HB2	2.56	0.41
1:C:426:PRO:HG2	1:C:429:PHE:HB2	2.02	0.41
2:B:38:ARG:HB3	2:B:48:ILE:HD11	2.03	0.40
2:B:140:GLN:N	2:B:238:GLN:HE22	2.18	0.40
1:C:386:LYS:H	1:C:386:LYS:HG2	1.72	0.40
1:A:462:LYS:HZ2	1:A:462:LYS:HG2	1.53	0.40
2:B:147:VAL:HG13	2:B:151:GLN:HB2	2.02	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	191/206 (93%)	182 (95%)	9 (5%)	0	100	100
1	C	192/206 (93%)	184 (96%)	8 (4%)	0	100	100
2	B	227/280 (81%)	222 (98%)	5 (2%)	0	100	100
2	D	227/280 (81%)	220 (97%)	7 (3%)	0	100	100
All	All	837/972 (86%)	808 (96%)	29 (4%)	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	166/176 (94%)	163 (98%)	3 (2%)	59	72
1	C	167/176 (95%)	165 (99%)	2 (1%)	71	83
2	B	197/228 (86%)	194 (98%)	3 (2%)	65	78
2	D	197/228 (86%)	191 (97%)	6 (3%)	41	53
All	All	727/808 (90%)	713 (98%)	14 (2%)	57	71

All (14) residues with a non-rotameric sidechain are listed below:

Mol	Chain	Res	Type
1	A	369	TYR
1	A	370	ASN

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Mol	Chain	Res	Type
1	A	493	GLN
2	B	65	LYS
2	B	152	ARG
2	B	232	ASP
1	C	360	ASN
1	C	386	LYS
2	D	62	GLN
2	D	63	LYS
2	D	87	ARG
2	D	144	SER
2	D	201	SER
2	D	245	LYS

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

Mol	Chain	Res	Type
1	C	481	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)

2 ligands 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	$\#\|Z\| > 2$
3	NAG	C	601	1	14,14,15	0.17	0	17,19,21	0.47	0
3	NAG	A	601	1	14,14,15	0.41	0	17,19,21	0.38	0

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
3	NAG	C	601	1	-	4/6/23/26	0/1/1/1
3	NAG	A	601	1	-	4/6/23/26	0/1/1/1

There are no bond length outliers.

There are no bond angle outliers.

There are no chirality outliers.

All (8) torsion outliers are listed below:

Mol	Chain	Res	Type	Atoms
3	C	601	NAG	O5-C5-C6-O6
3	C	601	NAG	C4-C5-C6-O6
3	A	601	NAG	C8-C7-N2-C2
3	A	601	NAG	O7-C7-N2-C2
3	C	601	NAG	C8-C7-N2-C2
3	C	601	NAG	O7-C7-N2-C2
3	A	601	NAG	C4-C5-C6-O6
3	A	601	NAG	O5-C5-C6-O6

There are no ring outliers.

No monomer is involved in short contacts.

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	193/206 (93%)	-0.19	3 (1%) 72 70	15, 26, 50, 62	0
1	C	194/206 (94%)	0.37	17 (8%) 10 8	26, 42, 64, 72	0
2	B	231/280 (82%)	0.02	7 (3%) 50 48	19, 36, 51, 65	0
2	D	231/280 (82%)	-0.20	0 100 100	19, 30, 44, 54	0
All	All	849/972 (87%)	-0.01	27 (3%) 47 45	15, 34, 57, 72	0

All (27) RSRZ outliers are listed below:

Mol	Chain	Res	Type	RSRZ
2	B	42	GLY	4.1
1	A	369	TYR	4.0
1	C	527	PRO	3.8
1	C	478	THR	3.6
1	C	519	HIS	3.0
1	A	521	PRO	3.0
1	C	475	ALA	2.9
1	C	369	TYR	2.9
2	B	43	GLN	2.8
1	C	373	SER	2.8
1	C	486	PHE	2.7
1	C	517	LEU	2.6
1	C	521	PRO	2.5
2	B	118	SER	2.4
1	C	361	CYS	2.3
1	C	334	ASN	2.3
1	C	428	ASP	2.2
1	C	336	CYS	2.2
1	C	370	ASN	2.2
1	C	362	VAL	2.2
1	C	481	ASN	2.1

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Mol	Chain	Res	Type	RSRZ
2	B	119	SER	2.1
2	B	153	ALA	2.1
1	A	335	LEU	2.1
1	C	522	ALA	2.1
2	B	17	SER	2.1
2	B	14	PRO	2.1

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)

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(Å^2)	Q<0.9
3	NAG	C	601	14/15	0.80	0.21	56,67,74,80	0
3	NAG	A	601	14/15	0.87	0.16	39,47,57,64	0

6.5 Other polymers (i)

There are no such residues in this entry.