wwPDB X-ray Structure Validation Summary Report (i)

Oct 8, 2023 – 11:31 PM EDT

PDB ID	:	6XKP
Title	:	Crystal structure of SARS-CoV-2 receptor binding domain in complex with neutralizing antibody CV07-270
Authors	:	Liu, H.; Yuan, M.; Zhu, X.; Wu, N.C.; Wilson, I.A.
Deposited on	:	2020-06-26
Resolution	:	2.72 Å(reported)

This is a wwPDB X-ray Structure Validation Summary 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:

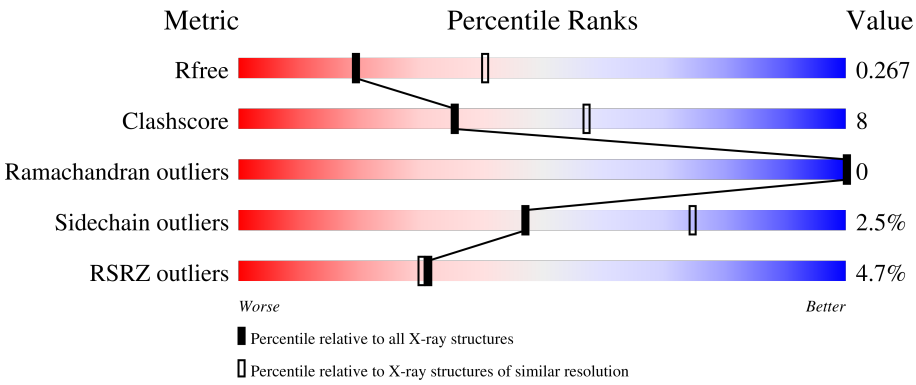
MolProbity	:	4.02b-467
Mogul	:	1.8.5 (274361), CSD as541be (2020)
Xtriage (Phenix)	:	1.13
EDS	:	2.35.1
Percentile statistics	:	20191225.v01 (using entries in the PDB archive December 25th 2019)
Refmac	:	5.8.0158
CCP4	:	7.0.044 (Gargrove)
Ideal geometry (proteins)	:	Engh & Huber (2001)
Ideal geometry (DNA, RNA)	:	Parkinson et al. (1996)
Validation Pipeline (wwPDB-VP)	:	2.35.1

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 2.72 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	3359 (2.74-2.70)
Clashscore	141614	3686 (2.74-2.70)
Ramachandran outliers	138981	3622 (2.74-2.70)
Sidechain outliers	138945	3623 (2.74-2.70)
RSRZ outliers	127900	3276 (2.74-2.70)

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	231	.% 68% 16% 16%
1	B	231	2% 66% 17% • 16%
2	H	232	.% 74% 20% 5%
2	M	232	79% 16% • •
3	L	216	8% 88% 10% •

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Mol	Chain	Length	Quality of chain
3	N	216	13% 86% 11%

2 Entry composition (i)

There are 5 unique types of molecules in this entry. The entry contains 9251 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	1438	921	242	267	8	0	0	0
1	B	194	1492	958	248	278	8	0	0	0

There are 16 discrepancies between the modelled and reference sequences:

Chain	Residue	Modelled	Actual	Comment	Reference
A	542	SER	-	expression tag	UNP P0DTC2
A	543	GLY	-	expression tag	UNP P0DTC2
A	544	HIS	-	expression tag	UNP P0DTC2
A	545	HIS	-	expression tag	UNP P0DTC2
A	546	HIS	-	expression tag	UNP P0DTC2
A	547	HIS	-	expression tag	UNP P0DTC2
A	548	HIS	-	expression tag	UNP P0DTC2
A	549	HIS	-	expression tag	UNP P0DTC2
B	542	SER	-	expression tag	UNP P0DTC2
B	543	GLY	-	expression tag	UNP P0DTC2
B	544	HIS	-	expression tag	UNP P0DTC2
B	545	HIS	-	expression tag	UNP P0DTC2
B	546	HIS	-	expression tag	UNP P0DTC2
B	547	HIS	-	expression tag	UNP P0DTC2
B	548	HIS	-	expression tag	UNP P0DTC2
B	549	HIS	-	expression tag	UNP P0DTC2

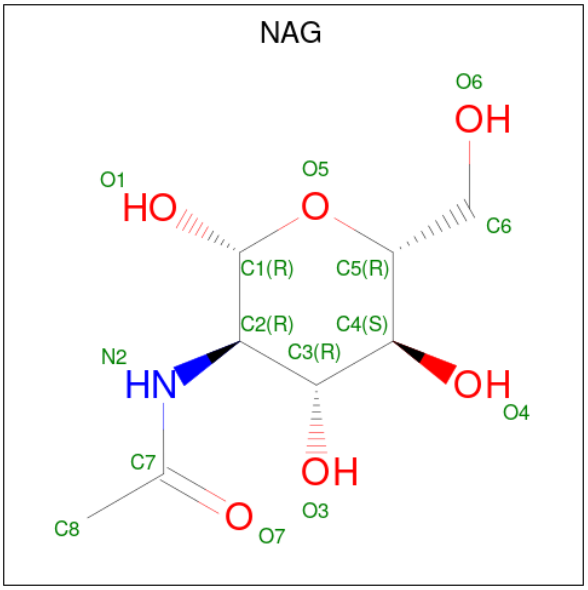
- Molecule 2 is a protein called CV07-270 Heavy Chain.

Mol	Chain	Residues	Atoms					ZeroOcc	AltConf	Trace
			Total	C	N	O	S			
2	H	220	1643	1048	279	310	6	0	0	0
2	M	224	1646	1049	278	313	6	0	0	0

- Molecule 3 is a protein called CV07-270 Light Chain.

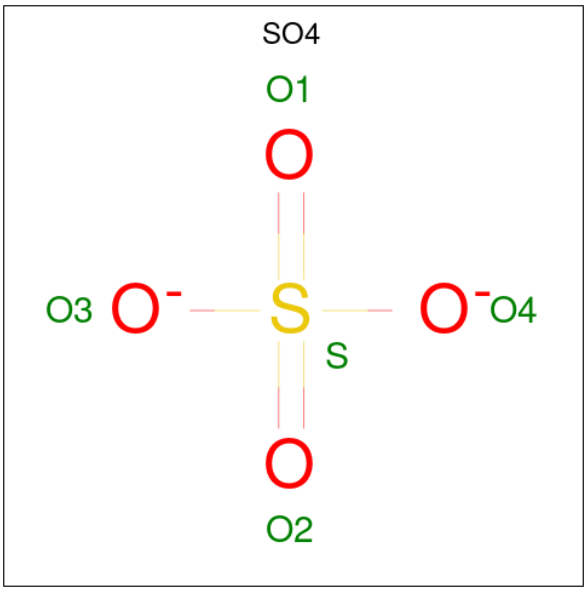
Mol	Chain	Residues	Atoms					ZeroOcc	AltConf	Trace
			Total	C	N	O	S			
3	L	211	1502	941	248	307	6	0	1	0
			Total	C	N	O	S			
3	N	210	1462	913	240	303	6	0	0	0

- Molecule 4 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		
4	A	1	14	8	1	5	0	0
			Total	C	N	O		
4	B	1	14	8	1	5	0	0

- Molecule 5 is SULFATE ION (three-letter code: SO4) (formula: O_4S).



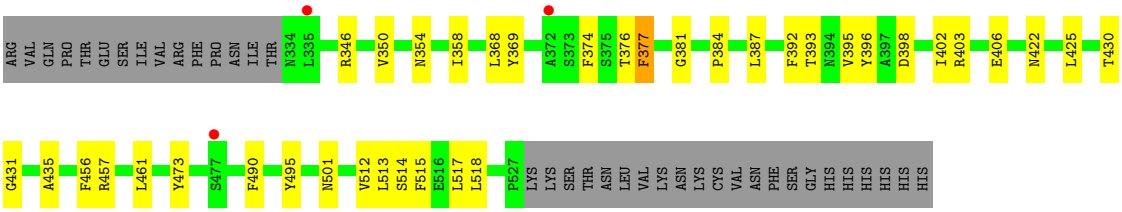
Mol	Chain	Residues	Atoms				ZeroOcc	AltConf
			Total	O	S			
5	H	1	5	4	1		0	0
			Total	O	S			
5	H	1	5	4	1		0	0
			Total	O	S			
5	H	1	5	4	1		0	0
			Total	O	S			
5	L	1	5	4	1		0	0
			Total	O	S			
5	L	1	5	4	1		0	0
			Total	O	S			
5	M	1	5	4	1		0	0
			Total	O	S			
5	M	1	5	4	1		0	0
			Total	O	S			
5	N	1	5	4	1		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.

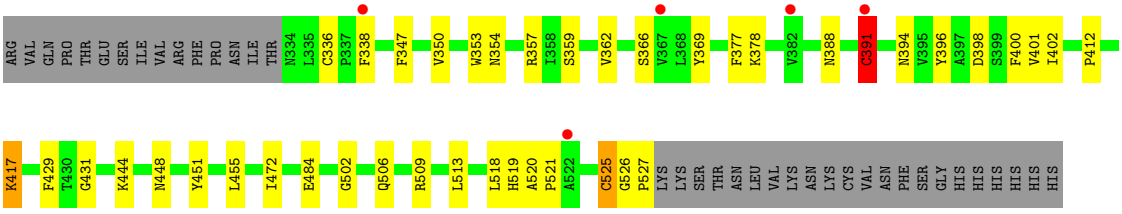
• Molecule 1: Spike protein S1

Chain A:



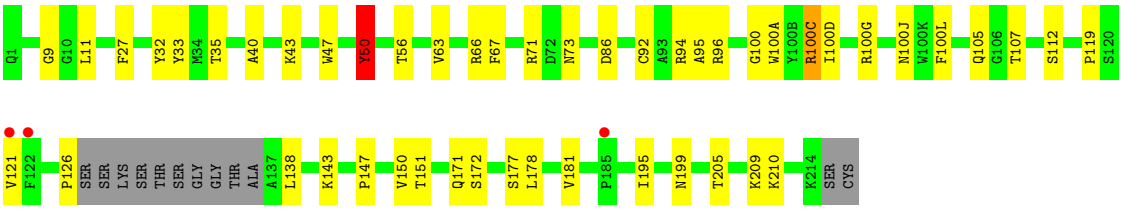
• Molecule 1: Spike protein S1

Chain B:



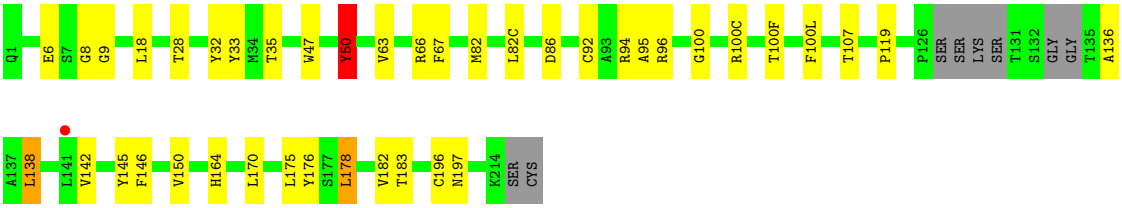
• Molecule 2: CV07-270 Heavy Chain

Chain H:

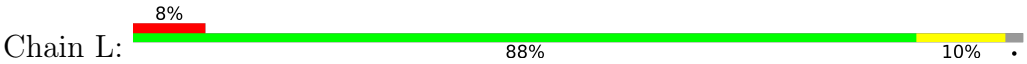


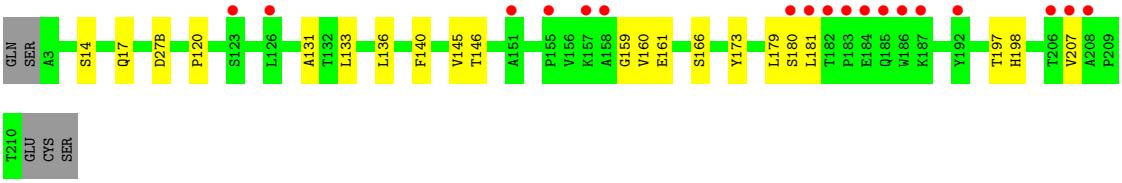
• Molecule 2: CV07-270 Heavy Chain

Chain M:

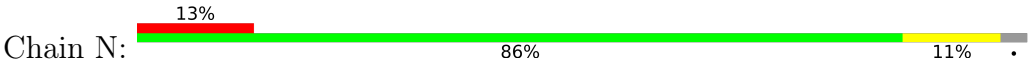


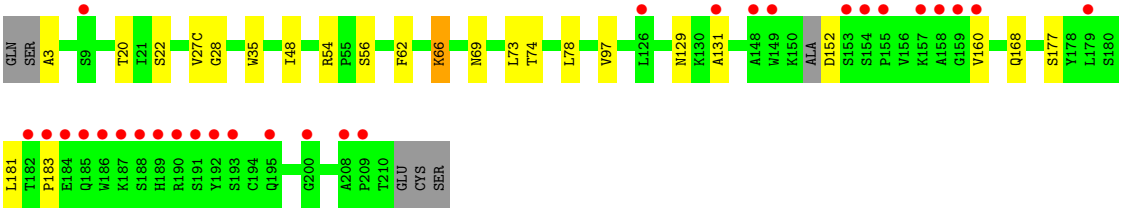
- Molecule 3: CV07-270 Light Chain





- Molecule 3: CV07-270 Light Chain





4 Data and refinement statistics (i)

Property	Value	Source
Space group	C 1 2 1	Depositor
Cell constants a, b, c, α, β, γ	175.02Å 151.78Å 66.02Å 90.00° 95.44° 90.00°	Depositor
Resolution (Å)	49.73 – 2.72 49.68 – 2.72	Depositor EDS
% Data completeness (in resolution range)	89.9 (49.73-2.72) 90.0 (49.68-2.72)	Depositor EDS
R_{merge}	0.20	Depositor
R_{sym}	(Not available)	Depositor
$< I/\sigma(I) >$ [1]	1.64 (at 2.73Å)	Xtriage
Refinement program	REFMAC 5	Depositor
R, R_{free}	0.220 , 0.269 0.219 , 0.267	Depositor DCC
R_{free} test set	2055 reflections (4.94%)	wwPDB-VP
Wilson B-factor (Å^2)	39.3	Xtriage
Anisotropy	0.109	Xtriage
Bulk solvent k_{sol}(e/Å^3), B_{sol}(Å^2)	0.34 , 51.6	EDS
L-test for twinning[2]	$< \|L\| > = 0.49$, $< L^2 > = 0.32$	Xtriage
Estimated twinning fraction	No twinning to report.	Xtriage
F_o,F_c correlation	0.91	EDS
Total number of atoms	9251	wwPDB-VP
Average B, all atoms (Å^2)	43.0	wwPDB-VP

Xtriage's analysis on translational NCS is as follows: *The largest off-origin peak in the Patterson function is 4.39% of the height of the origin peak. No significant pseudotranslation is detected.*

[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: SO4, 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	0.42	0/1479	0.61	0/2023
1	B	0.46	0/1536	0.67	3/2093 (0.1%)
2	H	0.43	0/1688	0.66	1/2303 (0.0%)
2	M	0.42	0/1690	0.66	2/2312 (0.1%)
3	L	0.40	0/1542	0.64	0/2118
3	N	0.37	0/1498	0.61	1/2057 (0.0%)
All	All	0.42	0/9433	0.64	7/12906 (0.1%)

There are no bond length outliers.

The worst 5 of 7 bond angle outliers are listed below:

Mol	Chain	Res	Type	Atoms	Z	Observed(^{o})	Ideal(^{o})
1	B	417	LYS	CA-CB-CG	7.34	129.55	113.40
1	B	417	LYS	CB-CG-CD	-6.39	94.99	111.60
2	M	178	LEU	CA-CB-CG	5.42	127.78	115.30
3	N	160	VAL	CG1-CB-CG2	5.40	119.54	110.90
2	H	50	TYR	CA-CB-CG	5.22	123.32	113.40

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	1438	0	1249	28	1
1	B	1492	0	1350	26	0
2	H	1643	0	1561	37	0
2	M	1646	0	1527	32	0
3	L	1502	0	1375	11	0
3	N	1462	0	1279	11	1
4	A	14	0	13	1	0
4	B	14	0	13	0	0
5	H	15	0	0	1	0
5	L	10	0	0	0	0
5	M	10	0	0	1	0
5	N	5	0	0	1	0
All	All	9251	0	8367	141	1

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.

The worst 5 of 141 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:M:47:TRP:HZ2	2:M:50:TYR:HD1	1.10	0.98
2:H:47:TRP:HZ2	2:H:50:TYR:HD1	1.14	0.90
2:M:47:TRP:HZ2	2:M:50:TYR:CD1	1.92	0.88
2:H:47:TRP:HZ2	2:H:50:TYR:CD1	1.97	0.83
2:M:47:TRP:CZ2	2:M:50:TYR:HD1	2.02	0.74

All (1) 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:A:501:ASN:ND2	3:N:56:SER:OG[1_554]	2.14	0.06

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	192/231 (83%)	184 (96%)	8 (4%)	0	100	100
1	B	192/231 (83%)	184 (96%)	8 (4%)	0	100	100
2	H	216/232 (93%)	210 (97%)	6 (3%)	0	100	100
2	M	218/232 (94%)	212 (97%)	6 (3%)	0	100	100
3	L	210/216 (97%)	205 (98%)	5 (2%)	0	100	100
3	N	206/216 (95%)	201 (98%)	5 (2%)	0	100	100
All	All	1234/1358 (91%)	1196 (97%)	38 (3%)	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	134/203 (66%)	133 (99%)	1 (1%)	84	93
1	B	150/203 (74%)	145 (97%)	5 (3%)	38	66
2	H	171/193 (89%)	166 (97%)	5 (3%)	42	70
2	M	166/193 (86%)	160 (96%)	6 (4%)	35	62
3	L	156/182 (86%)	154 (99%)	2 (1%)	69	86
3	N	144/182 (79%)	140 (97%)	4 (3%)	43	71
All	All	921/1156 (80%)	898 (98%)	23 (2%)	47	75

5 of 23 residues with a non-rotameric sidechain are listed below:

Mol	Chain	Res	Type
2	M	92	CYS
2	M	196	CYS
2	M	138	LEU
2	M	197	ASN
2	H	50	TYR

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

Mol	Chain	Res	Type
2	H	164	HIS
2	H	171	GLN
2	M	171	GLN

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)

10 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	$\#\|Z\| > 2$
5	SO4	N	301	-	4,4,4	0.13	0	6,6,6	0.29	0
5	SO4	L	301	-	4,4,4	0.15	0	6,6,6	0.16	0
5	SO4	H	303	-	4,4,4	0.14	0	6,6,6	0.08	0
4	NAG	A	1001	1	14,14,15	2.31	2 (14%)	17,19,21	2.56	3 (17%)
5	SO4	M	301	-	4,4,4	0.14	0	6,6,6	0.22	0
5	SO4	M	302	-	4,4,4	0.11	0	6,6,6	0.23	0
4	NAG	B	1001	1	14,14,15	0.95	1 (7%)	17,19,21	1.25	1 (5%)
5	SO4	H	302	-	4,4,4	0.11	0	6,6,6	0.10	0
5	SO4	L	302	-	4,4,4	0.13	0	6,6,6	0.22	0

Mol	Type	Chain	Res	Link	Bond lengths			Bond angles		
					Counts	RMSZ	$\#\|Z\| > 2$	Counts	RMSZ	$\#\|Z\| > 2$
5	SO4	H	301	-	4,4,4	0.13	0	6,6,6	0.22	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
4	NAG	B	1001	1	-	2/6/23/26	0/1/1/1
4	NAG	A	1001	1	-	4/6/23/26	0/1/1/1

All (3) bond length outliers are listed below:

Mol	Chain	Res	Type	Atoms	Z	Observed(Å)	Ideal(Å)
4	A	1001	NAG	O5-C1	7.11	1.55	1.43
4	A	1001	NAG	C1-C2	4.71	1.59	1.52
4	B	1001	NAG	O5-C1	-2.97	1.39	1.43

All (4) bond angle outliers are listed below:

Mol	Chain	Res	Type	Atoms	Z	Observed(^{o})	Ideal(^{o})
4	A	1001	NAG	C1-O5-C5	9.19	124.64	112.19
4	A	1001	NAG	C2-N2-C7	4.06	128.69	122.90
4	B	1001	NAG	C3-C4-C5	4.04	117.44	110.24
4	A	1001	NAG	C3-C4-C5	-2.16	106.39	110.24

There are no chirality outliers.

5 of 6 torsion outliers are listed below:

Mol	Chain	Res	Type	Atoms
4	B	1001	NAG	C4-C5-C6-O6
4	A	1001	NAG	C8-C7-N2-C2
4	A	1001	NAG	O7-C7-N2-C2
4	B	1001	NAG	O5-C5-C6-O6
4	A	1001	NAG	O5-C5-C6-O6

There are no ring outliers.

4 monomers are involved in 4 short contacts:

Mol	Chain	Res	Type	Clashes	Symm-Clashes
5	N	301	SO4	1	0
4	A	1001	NAG	1	0
5	M	302	SO4	1	0
5	H	302	SO4	1	0

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	194/231 (83%)	0.12	3 (1%)	73	76	18, 47, 84, 100	0
1	B	194/231 (83%)	0.01	5 (2%)	56	57	17, 38, 80, 89	0
2	H	220/232 (94%)	-0.02	3 (1%)	75	77	16, 34, 80, 99	0
2	M	224/232 (96%)	-0.07	1 (0%)	92	93	16, 38, 69, 83	0
3	L	211/216 (97%)	0.33	18 (8%)	10	9	13, 37, 78, 94	0
3	N	210/216 (97%)	0.54	29 (13%)	2	2	20, 52, 81, 99	0
All	All	1253/1358 (92%)	0.15	59 (4%)	31	30	13, 41, 81, 100	0

The worst 5 of 59 RSRZ outliers are listed below:

Mol	Chain	Res	Type	RSRZ
1	A	372	ALA	6.0
3	N	157	LYS	5.0
1	A	477	SER	5.0
3	L	158	ALA	4.5
3	L	126	LEU	4.4

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
4	NAG	A	1001	14/15	0.79	0.33	73,82,91,104	0
4	NAG	B	1001	14/15	0.83	0.30	55,71,79,84	0
5	SO4	L	302	5/5	0.86	0.19	63,71,83,93	0
5	SO4	L	301	5/5	0.94	0.16	60,66,91,92	0
5	SO4	M	301	5/5	0.96	0.15	50,52,69,81	0
5	SO4	M	302	5/5	0.96	0.19	51,55,57,67	0
5	SO4	N	301	5/5	0.96	0.14	44,46,49,68	0
5	SO4	H	301	5/5	0.97	0.15	45,45,62,63	0
5	SO4	H	302	5/5	0.98	0.12	33,39,49,50	0
5	SO4	H	303	5/5	0.99	0.17	48,51,63,71	0

6.5 Other polymers (i)

There are no such residues in this entry.