wwPDB EM Validation Summary Report

Nov 18, 2024 – 01:03 PM JST

PDB ID	:	8XZA
EMDB ID	:	EMD-38791
Title	:	BA.2.86 Spike in complex with bovine ACE2 (Local refinement)
Authors	:	Yue, C.; Liu, P.
Deposited on	:	2024-01-21
Resolution	:	4.07 Å(reported)

This is a wwPDB EM 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/EMValidationReportHelp
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:

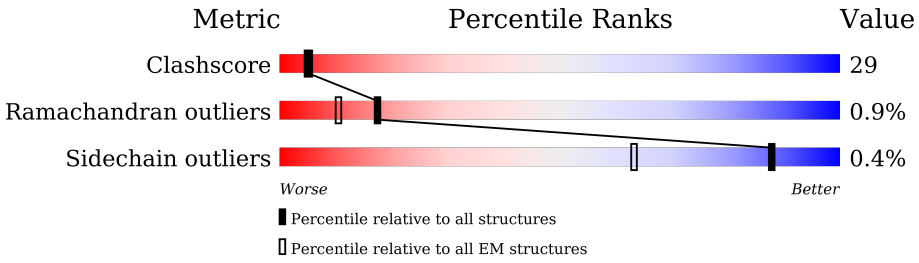
EMDB validation analysis	:	FAILED
Mogul	:	1.8.5 (274361), CSD as541be (2020)
MolProbity	:	4.02b-467
Percentile statistics	:	20231227.v01 (using entries in the PDB archive December 27th 2023)
MapQ	:	FAILED
Ideal geometry (proteins)	:	Engh & Huber (2001)
Ideal geometry (DNA, RNA)	:	Parkinson et al. (1996)
Validation Pipeline (wwPDB-VP)	:	2.39

1 Overall quality at a glance (i)

The following experimental techniques were used to determine the structure:
ELECTRON MICROSCOPY

The reported resolution of this entry is 4.07 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)	EM structures (#Entries)
Clashscore	210492	15764
Ramachandran outliers	207382	16835
Sidechain outliers	206894	16415

The table below summarises the geometric issues observed across the polymeric chains and their fit to the map. The red, orange, yellow and green segments of the 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	B	1206	7% 8% · 84%
2	A	804	41% 33% 26%

2 Entry composition (i)

There are 5 unique types of molecules in this entry. The entry contains 6565 atoms, of which 0 are hydrogens and 0 are deuteriums.

In the tables below, 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 glycoprotein.

Mol	Chain	Residues	Atoms					AltConf	Trace
			Total	C	N	O	S		
1	B	194	1559	1010	261	280	8	0	0

There are 73 discrepancies between the modelled and reference sequences:

Chain	Residue	Modelled	Actual	Comment	Reference
B	2	ALA	-	expression tag	UNP P0DTC2
B	3	THR	-	expression tag	UNP P0DTC2
B	20	MET	-	insertion	UNP P0DTC2
B	21	PRO	-	insertion	UNP P0DTC2
B	22	LEU	-	insertion	UNP P0DTC2
B	23	PHE	-	insertion	UNP P0DTC2
B	26	ILE	THR	conflict	UNP P0DTC2
B	28	THR	ARG	conflict	UNP P0DTC2
B	?	-	LEU	deletion	UNP P0DTC2
B	?	-	PRO	deletion	UNP P0DTC2
B	?	-	PRO	deletion	UNP P0DTC2
B	31	SER	ALA	variant	UNP P0DTC2
B	54	LEU	SER	conflict	UNP P0DTC2
B	?	-	HIS	deletion	UNP P0DTC2
B	?	-	VAL	deletion	UNP P0DTC2
B	129	PHE	VAL	conflict	UNP P0DTC2
B	144	ASP	GLY	variant	UNP P0DTC2
B	?	-	TYR	deletion	UNP P0DTC2
B	158	SER	PHE	conflict	UNP P0DTC2
B	159	GLY	ARG	conflict	UNP P0DTC2
B	?	-	ASN	deletion	UNP P0DTC2
B	212	ILE	LEU	variant	UNP P0DTC2
B	213	GLY	VAL	variant	UNP P0DTC2
B	216	PHE	LEU	variant	UNP P0DTC2
B	245	ASN	HIS	conflict	UNP P0DTC2
B	264	ASP	ALA	conflict	UNP P0DTC2
B	332	VAL	ILE	conflict	UNP P0DTC2
B	339	HIS	GLY	conflict	UNP P0DTC2

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Chain	Residue	Modelled	Actual	Comment	Reference
B	356	THR	LYS	conflict	UNP P0DTC2
B	371	PHE	SER	variant	UNP P0DTC2
B	373	PRO	SER	variant	UNP P0DTC2
B	375	PHE	SER	variant	UNP P0DTC2
B	376	ALA	THR	variant	UNP P0DTC2
B	403	LYS	ARG	conflict	UNP P0DTC2
B	405	ASN	ASP	variant	UNP P0DTC2
B	408	SER	ARG	variant	UNP P0DTC2
B	417	ASN	LYS	variant	UNP P0DTC2
B	440	LYS	ASN	variant	UNP P0DTC2
B	445	HIS	VAL	conflict	UNP P0DTC2
B	446	SER	GLY	variant	UNP P0DTC2
B	450	ASP	ASN	conflict	UNP P0DTC2
B	452	TRP	LEU	conflict	UNP P0DTC2
B	460	LYS	ASN	variant	UNP P0DTC2
B	477	ASN	SER	variant	UNP P0DTC2
B	478	LYS	THR	variant	UNP P0DTC2
B	481	LYS	ASN	conflict	UNP P0DTC2
B	?	-	VAL	deletion	UNP P0DTC2
B	483	LYS	GLU	variant	UNP P0DTC2
B	485	PRO	PHE	variant	UNP P0DTC2
B	497	ARG	GLN	variant	UNP P0DTC2
B	500	TYR	ASN	variant	UNP P0DTC2
B	504	HIS	TYR	variant	UNP P0DTC2
B	553	LYS	GLU	conflict	UNP P0DTC2
B	569	VAL	ALA	conflict	UNP P0DTC2
B	613	GLY	ASP	variant	UNP P0DTC2
B	620	SER	PRO	conflict	UNP P0DTC2
B	654	TYR	HIS	variant	UNP P0DTC2
B	678	LYS	ASN	variant	UNP P0DTC2
B	680	ARG	PRO	variant	UNP P0DTC2
B	682	ALA	ARG	conflict	UNP P0DTC2
B	684	ALA	ARG	conflict	UNP P0DTC2
B	763	LYS	ASN	variant	UNP P0DTC2
B	795	TYR	ASP	variant	UNP P0DTC2
B	816	PRO	PHE	conflict	UNP P0DTC2
B	891	PRO	ALA	conflict	UNP P0DTC2
B	898	PRO	ALA	conflict	UNP P0DTC2
B	938	PHE	SER	conflict	UNP P0DTC2
B	941	PRO	ALA	conflict	UNP P0DTC2
B	953	HIS	GLN	variant	UNP P0DTC2
B	968	LYS	ASN	variant	UNP P0DTC2

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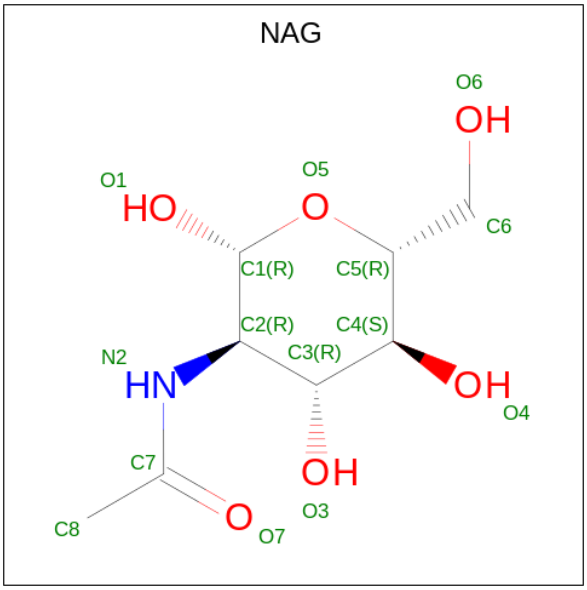
Chain	Residue	Modelled	Actual	Comment	Reference
B	985	PRO	LYS	variant	UNP P0DTC2
B	986	PRO	VAL	variant	UNP P0DTC2
B	1142	LEU	PRO	conflict	UNP P0DTC2

- Molecule 2 is a protein called Angiotensin-converting enzyme.

Mol	Chain	Residues	Atoms					AltConf	Trace
2	A	596	Total	C	N	O	S	0	0
			4906	3136	815	925	30		

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



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

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

- Molecule 4 is ZINC ION (three-letter code: ZN) (formula: Zn).

Mol	Chain	Residues	Atoms		AltConf
4	A	1	Total	Zn	0
			1	1	

- Molecule 5 is CHLORIDE ION (three-letter code: CL) (formula: Cl).

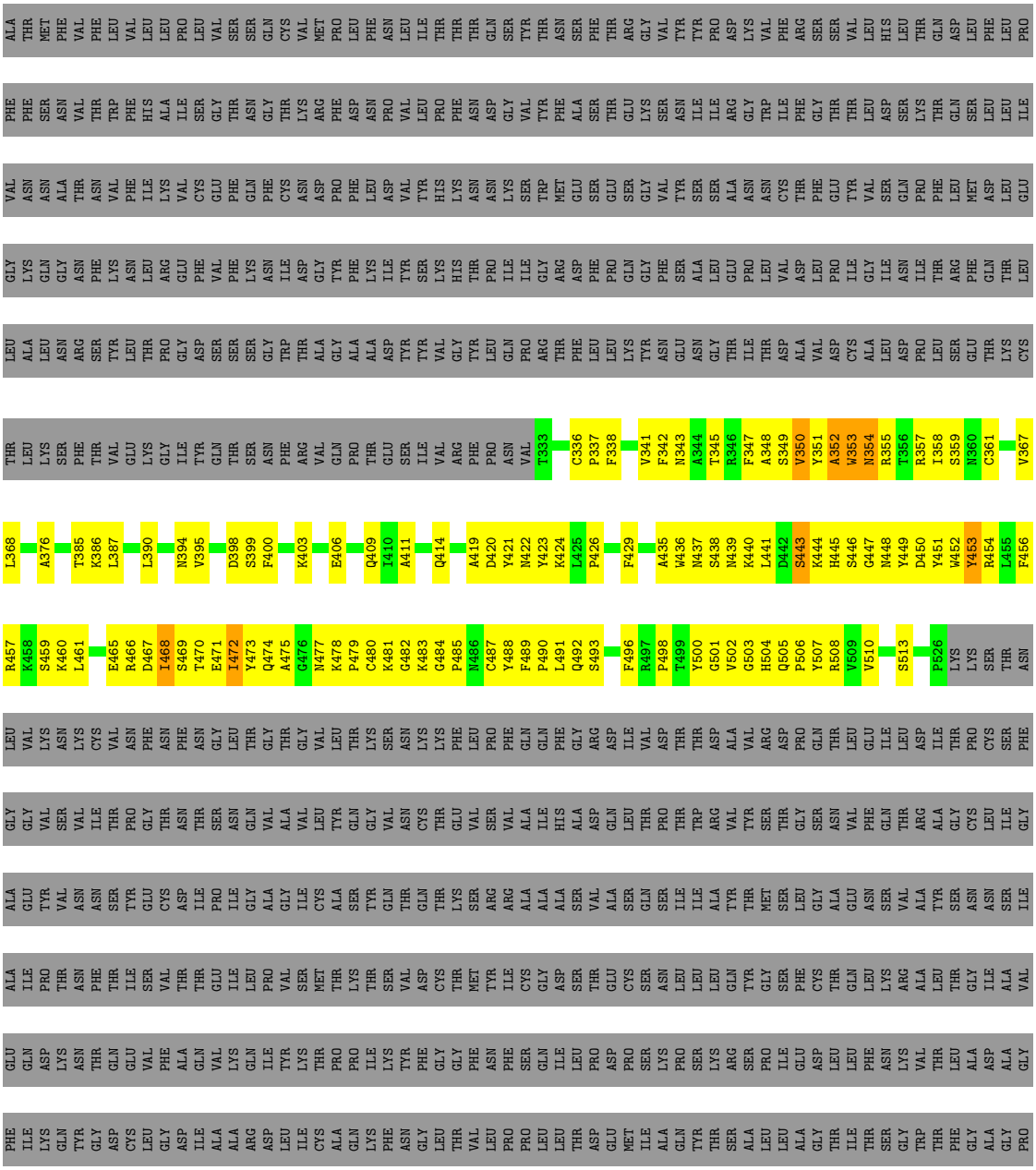
Mol	Chain	Residues	Atoms		AltConf
5	A	1	Total	Cl	0
			1	1	

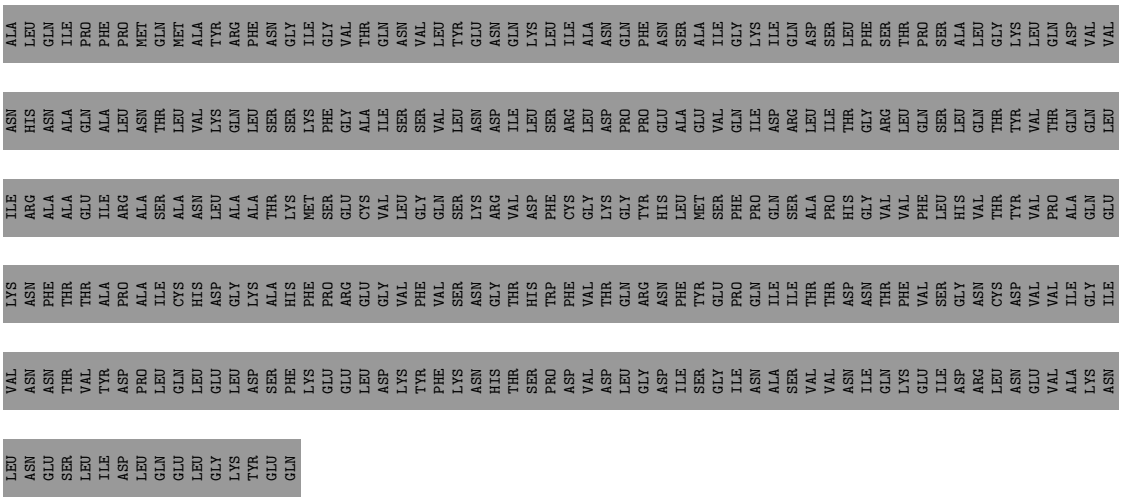
3 Residue-property plots (i)

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. 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: Spike glycoprotein

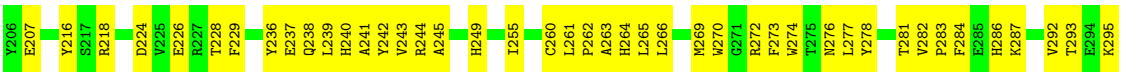
Chain B:

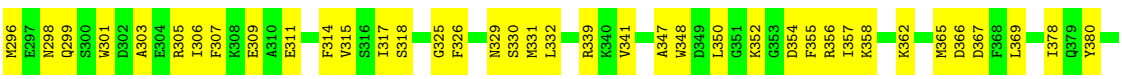


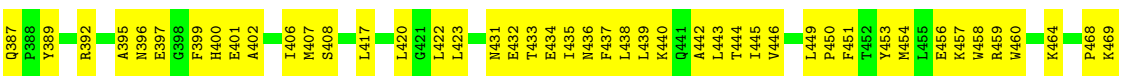


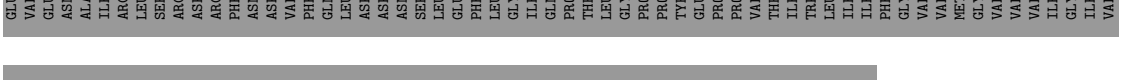
• Molecule 2: Angiotensin-converting enzyme

Chain A:









4 Experimental information (i)

Property	Value	Source
EM reconstruction method	SINGLE PARTICLE	Depositor
Imposed symmetry	POINT, Not provided	
Number of particles used	281776	Depositor
Resolution determination method	FSC 0.143 CUT-OFF	Depositor
CTF correction method	PHASE FLIPPING ONLY	Depositor
Microscope	FEI TALOS ARCTICA	Depositor
Voltage (kV)	200	Depositor
Electron dose ($e^-/Å^2$)	60	Depositor
Minimum defocus (nm)	1200	Depositor
Maximum defocus (nm)	2000	Depositor
Magnification	Not provided	
Image detector	GATAN K2 SUMMIT (4k x 4k)	Depositor

5 Model quality

5.1 Standard geometry

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

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	B	0.54	0/1611	0.70	2/2193 (0.1%)
2	A	0.31	0/5043	0.57	0/6838
All	All	0.38	0/6654	0.60	2/9031 (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	2

There are no bond length outliers.

All (2) bond angle outliers are listed below:

Mol	Chain	Res	Type	Atoms	Z	Observed(^{o})	Ideal(^{o})
1	B	352	ALA	N-CA-C	-6.46	93.57	111.00
1	B	468	ILE	N-CA-C	-5.09	97.26	111.00

There are no chirality outliers.

All (2) planarity outliers are listed below:

Mol	Chain	Res	Type	Group
1	B	345	THR	Mainchain
1	B	350	VAL	Mainchain

5.2 Too-close contacts

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	B	1559	0	1479	140	0
2	A	4906	0	4691	243	0
3	A	70	0	65	0	0
3	B	28	0	26	2	0
4	A	1	0	0	0	0
5	A	1	0	0	0	0
All	All	6565	0	6261	371	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 29.

The worst 5 of 371 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:353:TRP:HA	1:B:400:PHE:HE1	1.08	1.18
1:B:349:SER:OG	1:B:351:TYR:CE2	1.98	1.15
1:B:351:TYR:HE2	1:B:452:TRP:N	1.43	1.14
1:B:484:GLY:H	1:B:487:CYS:HB2	1.12	1.13
1:B:353:TRP:CH2	1:B:355:ARG:HD2	1.73	1.10

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 PDB entries followed by that with respect to all EM entries.

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	B	192/1206 (16%)	154 (80%)	31 (16%)	7 (4%)	3 24

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Mol	Chain	Analysed	Favoured	Allowed	Outliers	Percentiles
2	A	594/804 (74%)	562 (95%)	32 (5%)	0	100 100
All	All	786/2010 (39%)	716 (91%)	63 (8%)	7 (1%)	17 50

5 of 7 Ramachandran outliers are listed below:

Mol	Chain	Res	Type
1	B	353	TRP
1	B	502	VAL
1	B	472	ILE
1	B	354	ASN
1	B	475	ALA

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 PDB entries followed by that with respect to all EM entries.

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	B	168/1054 (16%)	165 (98%)	3 (2%)	54 72
2	A	525/711 (74%)	525 (100%)	0	100 100
All	All	693/1765 (39%)	690 (100%)	3 (0%)	88 91

All (3) residues with a non-rotameric sidechain are listed below:

Mol	Chain	Res	Type
1	B	443	SER
1	B	446	SER
1	B	453	TYR

Sometimes sidechains can be flipped to improve hydrogen bonding and reduce clashes. 5 of 10 such sidechains are listed below:

Mol	Chain	Res	Type
2	A	264	HIS
2	A	299	GLN
2	A	598	ASN

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Mol	Chain	Res	Type
1	B	474	GLN
2	A	42	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 oligosaccharides in this entry.

5.6 Ligand geometry (i)

Of 9 ligands modelled in this entry, 2 are monoatomic - leaving 7 for Mogul analysis.

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	A	902	2	14,14,15	0.30	0	17,19,21	0.30	0
3	NAG	A	903	2	14,14,15	0.21	0	17,19,21	0.41	0
3	NAG	B	1301	-	14,14,15	0.26	0	17,19,21	1.42	2 (11%)
3	NAG	B	1302	1	14,14,15	0.38	0	17,19,21	0.48	0
3	NAG	A	904	2	14,14,15	0.74	1 (7%)	17,19,21	1.49	3 (17%)
3	NAG	A	906	2	14,14,15	0.20	0	17,19,21	0.47	0
3	NAG	A	905	2	14,14,15	0.29	0	17,19,21	0.49	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	A	902	2	-	2/6/23/26	0/1/1/1
3	NAG	A	903	2	-	0/6/23/26	0/1/1/1
3	NAG	B	1301	-	-	4/6/23/26	0/1/1/1
3	NAG	B	1302	1	-	1/6/23/26	0/1/1/1
3	NAG	A	904	2	-	1/6/23/26	0/1/1/1
3	NAG	A	906	2	-	4/6/23/26	0/1/1/1
3	NAG	A	905	2	-	3/6/23/26	0/1/1/1

All (1) bond length outliers are listed below:

Mol	Chain	Res	Type	Atoms	Z	Observed(Å)	Ideal(Å)
3	A	904	NAG	C1-C2	2.10	1.55	1.52

All (5) bond angle outliers are listed below:

Mol	Chain	Res	Type	Atoms	Z	Observed(^{o})	Ideal(^{o})
3	A	904	NAG	C1-O5-C5	4.60	118.42	112.19
3	B	1301	NAG	O5-C1-C2	-3.48	105.79	111.29
3	B	1301	NAG	C4-C3-C2	-3.10	106.48	111.02
3	A	904	NAG	C2-N2-C7	2.39	126.31	122.90
3	A	904	NAG	C1-C2-N2	2.04	113.97	110.49

There are no chirality outliers.

5 of 15 torsion outliers are listed below:

Mol	Chain	Res	Type	Atoms
3	B	1301	NAG	C8-C7-N2-C2
3	B	1301	NAG	O7-C7-N2-C2
3	A	902	NAG	O5-C5-C6-O6
3	A	906	NAG	C4-C5-C6-O6
3	A	906	NAG	O5-C5-C6-O6

There are no ring outliers.

2 monomers are involved in 2 short contacts:

Mol	Chain	Res	Type	Clashes	Symm-Clashes
3	B	1301	NAG	1	0
3	B	1302	NAG	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.