Full wwPDB X-ray Structure Validation Report ⓘ

Apr 21, 2026 – 02:58 AM JST

PDB ID	:	9UOI / pdb_00009uoi
Title	:	Crystal structure of nanobody Tnb316 with nanobody B9 and MERS-CoV RBD
Authors	:	Wang, X.; Lin, Z.
Deposited on	:	2025-04-25
Resolution	:	1.96 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:

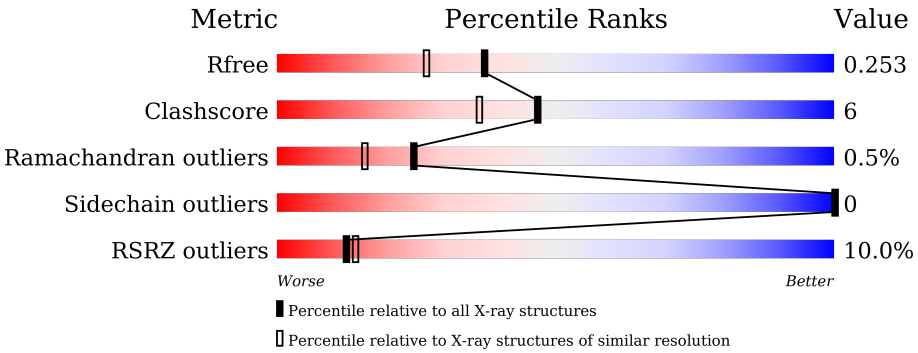
MolProbity	:	4-5-2 with Phenix2.0
Mogul	:	1.8.5 (274361), CSD as541be (2020)
Xtriage (Phenix)	:	2.0
EDS	:	3.0
Percentile statistics	:	20250101.v01 (using entries in the PDB archive January 1st 2025)
CCP4	:	9.0.010 (Gargrove)
Density-Fitness	:	1.0.12
Ideal geometry (proteins)	:	Engh & Huber (2001)
Ideal geometry (DNA, RNA)	:	Parkinson et al. (1996)
Validation Pipeline (wwPDB-VP)	:	2.49

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 1.96 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}	180053	3494 (1.96-1.96)
Clashscore	190562	3612 (1.96-1.96)
Ramachandran outliers	187476	3587 (1.96-1.96)
Sidechain outliers	187428	3587 (1.96-1.96)
RSRZ outliers	180081	3495 (1.96-1.96)

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	C	127	12% 80% 10% • 9%
2	A	116	8% 91% 9%
3	B	208	10% 83% 15% •
4	D	2	100%

2 Entry composition (i)

There are 5 unique types of molecules in this entry. The entry contains 3600 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 nanobody B9.

Mol	Chain	Residues	Atoms					ZeroOcc	AltConf	Trace
1	C	115	Total	C	N	O	S	0	0	0
			879	552	149	174	4			

- Molecule 2 is a protein called nanobody Tnb316.

Mol	Chain	Residues	Atoms					ZeroOcc	AltConf	Trace
2	A	116	Total	C	N	O	S	0	0	0
			889	556	157	171	5			

- Molecule 3 is a protein called Spike glycoprotein.

Mol	Chain	Residues	Atoms					ZeroOcc	AltConf	Trace
3	B	207	Total	C	N	O	S	0	0	0
			1596	1020	255	310	11			

- Molecule 4 is an oligosaccharide called 2-acetamido-2-deoxy-beta-D-glucopyranose-(1-4)-2-acetamido-2-deoxy-beta-D-glucopyranose.

Mol	Chain	Residues	Atoms				ZeroOcc	AltConf	Trace
4	D	2	Total	C	N	O	0	0	0
			28	16	2	10			

- Molecule 5 is water.

Mol	Chain	Residues	Atoms		ZeroOcc	AltConf
5	C	51	Total	O	0	0
			51	51		

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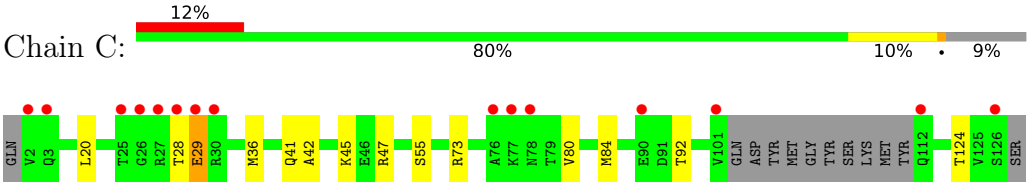
Mol	Chain	Residues	Atoms	ZeroOcc	AltConf
5	A	61	Total O 61 61	0	0
5	B	96	Total O 96 96	0	0

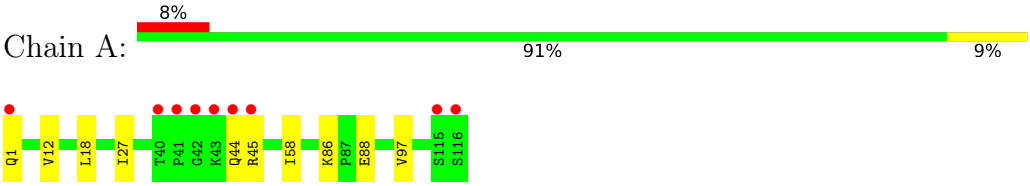
3 Residue-property plots (i)

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.

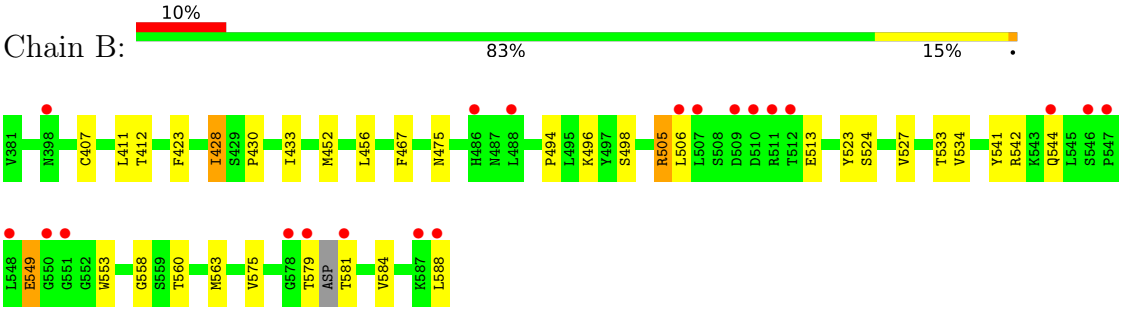
• Molecule 1: nanobody B9



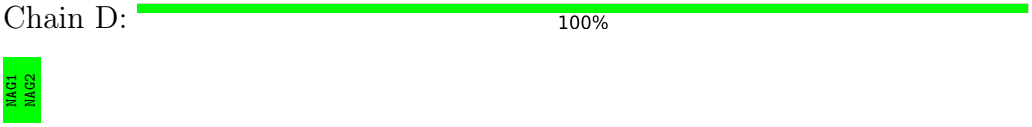
• Molecule 2: nanobody Tnb316



• Molecule 3: Spike glycoprotein



• Molecule 4: 2-acetamido-2-deoxy-beta-D-glucopyranose-(1-4)-2-acetamido-2-deoxy-beta-D-glucopyranose



4 Data and refinement statistics (i)

Property	Value	Source
Space group	P 21 21 21	Depositor
Cell constants a, b, c, α, β, γ	55.72Å 60.41Å 126.24Å 90.00° 90.00° 90.00°	Depositor
Resolution (Å)	63.12 – 1.96 63.12 – 1.96	Depositor EDS
% Data completeness (in resolution range)	93.5 (63.12-1.96) 93.5 (63.12-1.96)	Depositor EDS
R_{merge}	(Not available)	Depositor
R_{sym}	(Not available)	Depositor
$< I/\sigma(I) >$ [1]	3.57 (at 1.95Å)	Xtriage
Refinement program	PHENIX (1.18.2_3874: ???)	Depositor
R, R_{free}	0.200 , 0.253 0.203 , 0.253	Depositor DCC
R_{free} test set	1990 reflections (6.34%)	wwPDB-VP
Wilson B-factor (Å^2)	20.3	Xtriage
Anisotropy	0.036	Xtriage
Bulk solvent k_{sol}(e/Å^3), B_{sol}(Å^2)	0.35 , 33.8	EDS
L-test for twinning[2]	$< \|L\| > = 0.46$, $< L^2 > = 0.29$	Xtriage
Estimated twinning fraction	No twinning to report.	Xtriage
F_o,F_c correlation	0.94	EDS
Total number of atoms	3600	wwPDB-VP
Average B, all atoms (Å^2)	24.0	wwPDB-VP

Xtriage's analysis on translational NCS is as follows: *The largest off-origin peak in the Patterson function is 5.92% 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

5.1 Standard geometry

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	C	0.56	0/898	0.84	0/1217
2	A	0.48	0/908	0.76	0/1230
3	B	0.47	1/1634 (0.1%)	0.75	6/2230 (0.3%)
All	All	0.50	1/3440 (0.0%)	0.78	6/4677 (0.1%)

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
3	B	0	1

All (1) bond length outliers are listed below:

Mol	Chain	Res	Type	Atoms	Z	Observed(Å)	Ideal(Å)
3	B	428	ILE	C-N	-5.07	1.26	1.32

All (6) bond angle outliers are listed below:

Mol	Chain	Res	Type	Atoms	Z	Observed(^{o})	Ideal(^{o})
3	B	541	TYR	CA-C-N	-8.47	108.81	122.36
3	B	541	TYR	C-N-CA	-8.47	108.81	122.36
3	B	428	ILE	O-C-N	-6.50	114.44	122.57
3	B	505	ARG	CG-CD-NE	5.84	124.86	112.00
3	B	423	PHE	CA-CB-CG	5.07	118.87	113.80
3	B	549	GLU	N-CA-C	-5.03	107.17	113.15

There are no chirality outliers.

All (1) planarity outliers are listed below:

Mol	Chain	Res	Type	Group
3	B	542	ARG	Mainchain

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	C	879	0	819	7	0
2	A	889	0	870	8	0
3	B	1596	0	1564	24	0
4	D	28	0	25	0	0
5	A	61	0	0	2	0
5	B	96	0	0	3	0
5	C	51	0	0	0	0
All	All	3600	0	3278	38	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 6.

All (38) 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:C:42:ALA:HB3	1:C:45:LYS:HD2	1.68	0.76
3:B:534:VAL:HG23	3:B:560:THR:HG22	1.75	0.68
2:A:1:GLN:O	5:A:201:HOH:O	2.15	0.65
3:B:506:LEU:HD23	3:B:513:GLU:HG2	1.80	0.64
2:A:58:ILE:HD11	3:B:412:THR:HA	1.84	0.60
1:C:36:MET:HG3	1:C:80:VAL:HG21	1.83	0.59
3:B:505:ARG:NH2	3:B:549:GLU:O	2.39	0.56
3:B:544:GLN:HG2	3:B:553:TRP:CZ3	2.40	0.56
3:B:498:SER:OG	3:B:534:VAL:HG22	2.07	0.54
2:A:12:VAL:HG21	2:A:18:LEU:HG	1.90	0.52
2:A:27:ILE:CD1	2:A:97:VAL:HG11	2.39	0.52
3:B:494:PRO:O	3:B:563:MET:HE3	2.10	0.52
2:A:86:LYS:NZ	5:A:202:HOH:O	2.42	0.52
2:A:86:LYS:NZ	2:A:88:GLU:OE2	2.41	0.51
2:A:44:GLN:HG3	2:A:45:ARG:H	1.76	0.51
3:B:496:LYS:HD3	3:B:560:THR:HB	1.93	0.49

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Atom-1	Atom-2	Interatomic distance (Å)	Clash overlap (Å)
2:A:27:ILE:HD13	2:A:97:VAL:HG21	1.94	0.48
1:C:41:GLN:HB2	1:C:47:ARG:HG2	1.95	0.48
3:B:523:TYR:HB3	3:B:527:VAL:HG11	1.97	0.47
3:B:430:PRO:O	3:B:433:ILE:HG22	2.16	0.46
3:B:534:VAL:HG11	3:B:558:GLY:HA3	1.98	0.46
3:B:496:LYS:HE2	5:B:686:HOH:O	2.16	0.45
3:B:534:VAL:CG2	3:B:560:THR:HG22	2.44	0.45
1:C:20:LEU:HG	1:C:84:MET:HE2	1.99	0.44
3:B:411:LEU:HD23	3:B:411:LEU:HA	1.86	0.44
3:B:533:THR:HG23	5:B:619:HOH:O	2.18	0.44
1:C:28:THR:O	1:C:29:GLU:HB2	2.17	0.43
3:B:524:SER:HB3	3:B:527:VAL:HG13	1.99	0.43
3:B:467:PHE:O	3:B:524:SER:HB2	2.18	0.43
3:B:475:ASN:HB3	3:B:575:VAL:O	2.19	0.42
3:B:407:CYS:O	3:B:584:VAL:HA	2.19	0.42
1:C:55:SER:O	1:C:73:ARG:NH1	2.49	0.42
3:B:498:SER:CB	3:B:534:VAL:HG22	2.50	0.42
3:B:588:LEU:HD13	5:B:696:HOH:O	2.19	0.41
3:B:456:LEU:HD23	3:B:456:LEU:HA	1.88	0.41
3:B:579:THR:O	3:B:581:THR:N	2.53	0.41
1:C:92:THR:HG23	1:C:124:THR:HA	2.03	0.41
3:B:452:MET:HE2	3:B:452:MET:HB3	1.89	0.41

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	C	111/127 (87%)	108 (97%)	2 (2%)	1 (1%)	14 6
2	A	114/116 (98%)	112 (98%)	2 (2%)	0	100 100
3	B	203/208 (98%)	200 (98%)	2 (1%)	1 (0%)	24 16

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Mol	Chain	Analysed	Favoured	Allowed	Outliers	Percentiles
All	All	428/451 (95%)	420 (98%)	6 (1%)	2 (0%)	24 16

All (2) Ramachandran outliers are listed below:

Mol	Chain	Res	Type
1	C	29	GLU
3	B	428	ILE

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	C	89/103 (86%)	89 (100%)	0	100 100
2	A	97/97 (100%)	97 (100%)	0	100 100
3	B	188/190 (99%)	188 (100%)	0	100 100
All	All	374/390 (96%)	374 (100%)	0	100 100

There are no protein residues with a non-rotameric sidechain to report.

Sometimes sidechains can be flipped to improve hydrogen bonding and reduce clashes. All (5) such sidechains are listed below:

Mol	Chain	Res	Type
1	C	122	GLN
2	A	1	GLN
2	A	101	HIS
3	B	544	GLN
3	B	566	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)

2 monosaccharides 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	$\#\|Z\| > 2$
4	NAG	D	1	4,3	14,14,15	0.29	0	17,19,21	0.81	0
4	NAG	D	2	4	14,14,15	0.43	0	17,19,21	0.78	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	D	1	4,3	-	0/6/23/26	0/1/1/1
4	NAG	D	2	4	-	1/6/23/26	0/1/1/1

There are no bond length outliers.

There are no bond angle outliers.

There are no chirality outliers.

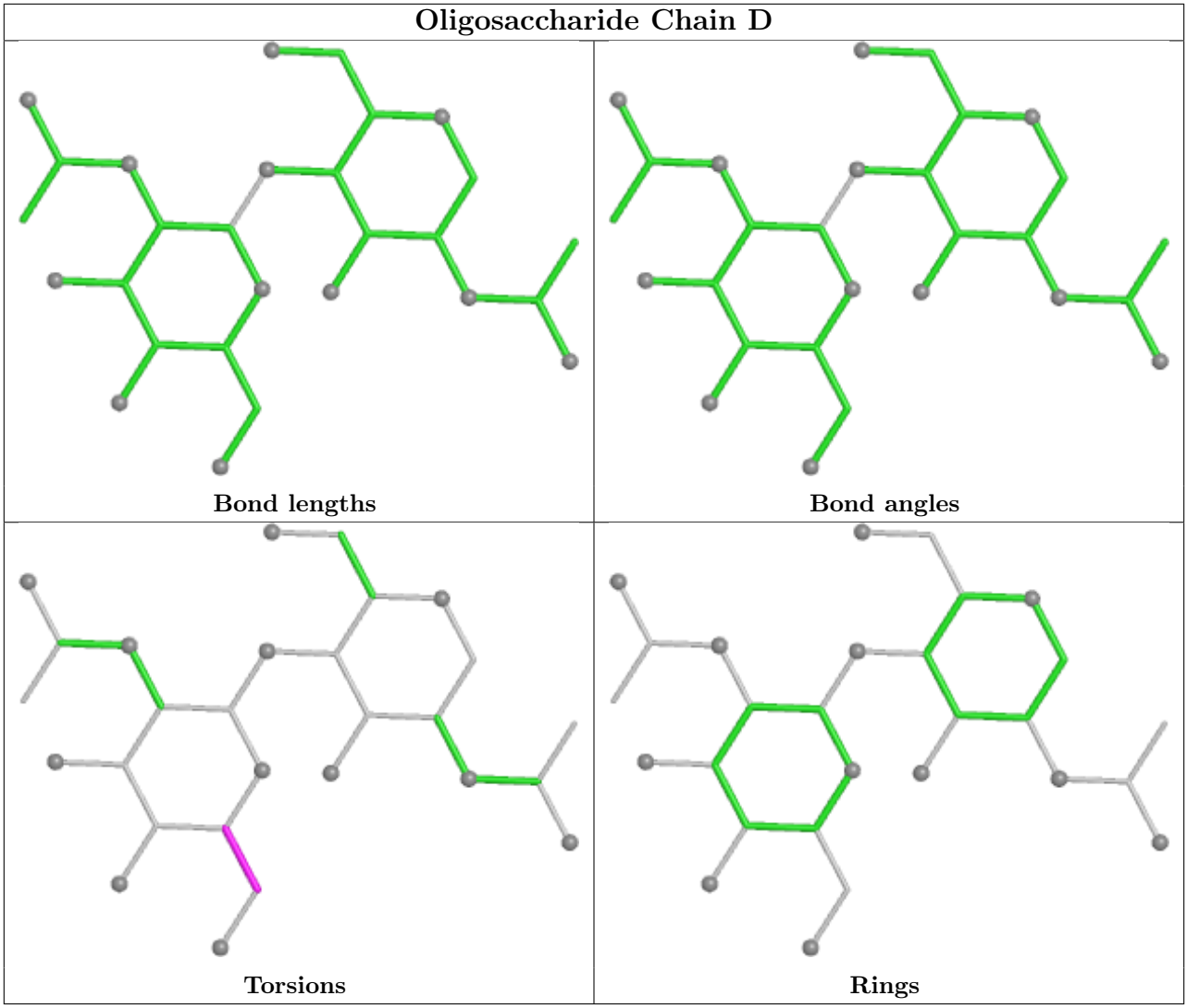
All (1) torsion outliers are listed below:

Mol	Chain	Res	Type	Atoms
4	D	2	NAG	O5-C5-C6-O6

There are no ring outliers.

No monomer is involved in short contacts.

The following is a two-dimensional graphical depiction of Mogul quality analysis of bond lengths, bond angles, torsion angles, and ring geometry for oligosaccharide.



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^{th} 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	C	115/127 (90%)	0.46	15 (13%) 7 8	13, 21, 47, 62	0
2	A	116/116 (100%)	0.16	9 (7%) 19 22	11, 19, 44, 61	0
3	B	207/208 (99%)	0.27	20 (9%) 13 15	11, 21, 50, 72	0
All	All	438/451 (97%)	0.29	44 (10%) 12 14	11, 21, 50, 72	0

All (44) RSRZ outliers are listed below:

Mol	Chain	Res	Type	RSRZ
2	A	43	LYS	4.7
2	A	42	GLY	4.6
1	C	27	ARG	4.4
2	A	41	PRO	4.4
2	A	40	THR	4.3
3	B	548	LEU	4.0
3	B	546	SER	3.9
2	A	116	SER	3.8
1	C	90	GLU	3.7
3	B	588	LEU	3.7
1	C	2	VAL	3.7
1	C	101	VAL	3.5
3	B	510	ASP	3.5
2	A	115	SER	3.5
1	C	28	THR	3.3
3	B	488	LEU	3.1
3	B	581	THR	3.0
2	A	44	GLN	3.0
1	C	77	LYS	3.0
3	B	507	LEU	2.9
3	B	550	GLY	2.9
1	C	25	THR	2.8
3	B	587	LYS	2.7

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Mol	Chain	Res	Type	RSRZ
1	C	112	GLN	2.6
1	C	30	ARG	2.6
3	B	551	GLY	2.6
1	C	76	ALA	2.6
3	B	547	PRO	2.6
3	B	511	ARG	2.5
1	C	126	SER	2.5
3	B	544	GLN	2.5
3	B	579	THR	2.5
3	B	506	LEU	2.5
1	C	26	GLY	2.3
2	A	1	GLN	2.3
1	C	78	ASN	2.3
3	B	578	GLY	2.3
3	B	512	THR	2.3
1	C	29	GLU	2.2
1	C	3	GLN	2.2
3	B	398	ASN	2.2
3	B	486	HIS	2.2
2	A	45	ARG	2.1
3	B	509	ASP	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)

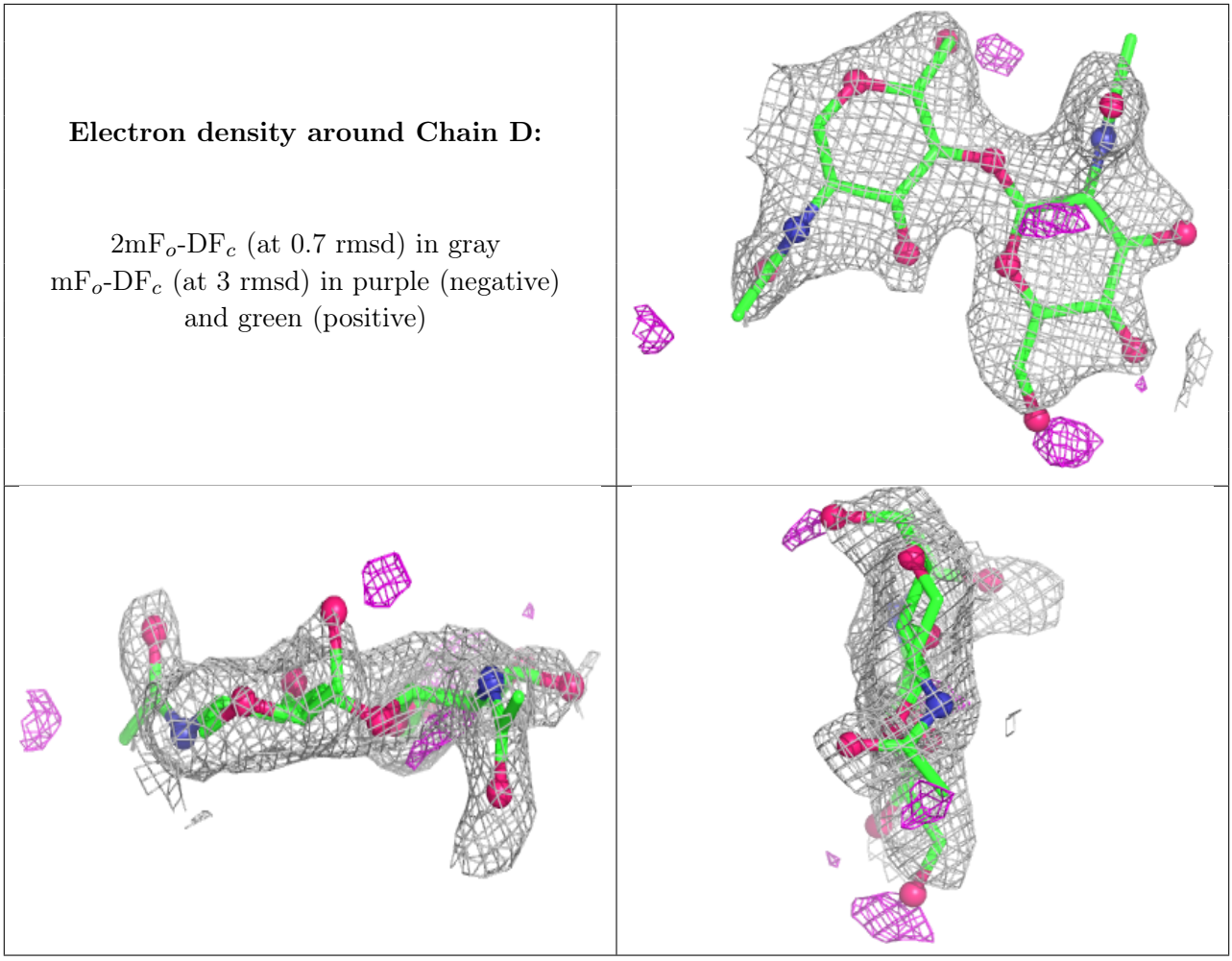
In the following table, the Atoms column lists the number of modelled atoms in the group and the number defined in the chemical component dictionary. The B-factors column lists the minimum, median, 95^{th} percentile and maximum values of B factors of atoms in the group. The column labelled 'Q< 0.9' 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	D	2	14/15	0.69	0.14	39,45,50,50	0
4	NAG	D	1	14/15	0.86	0.10	32,38,43,44	0

The following is a graphical depiction of the model fit to experimental electron density for oligosaccharide. Each fit is shown from different orientation to approximate a three-dimensional view.

Electron density around Chain D:

$2mF_o$-DF_c (at 0.7 rmsd) in gray
mF_o-DF_c (at 3 rmsd) in purple (negative) and green (positive)



6.4 Ligands

There are no ligands in this entry.

6.5 Other polymers

There are no such residues in this entry.