



# Full wwPDB X-ray Structure Validation Report ⓘ

Sep 26, 2023 – 06:48 AM EDT

PDB ID : 6ARQ  
Title : Crystal structure of CD96 (D1) bound to CD155/necl-5 (D1-3)  
Authors : Deuss, F.A.; Watson, G.M.; Rossjohn, J.; Berry, R.  
Deposited on : 2017-08-23  
Resolution : 2.88 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>.

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The following versions of software and data (see [references ⓘ](#)) were used in the production of this report:

MolProbity : 4.02b-467  
Mogul : 1.8.5 (274361), CSD as541be (2020)  
Xtrriage (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

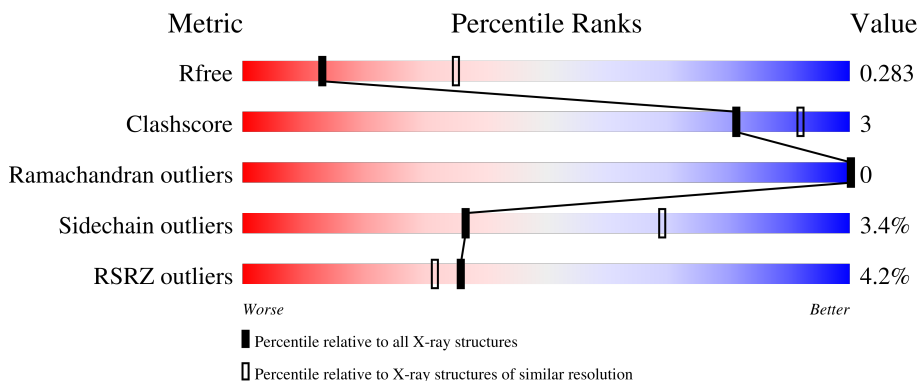
# 1 Overall quality at a glance

The following experimental techniques were used to determine the structure:

*X-RAY DIFFRACTION*

The reported resolution of this entry is 2.88 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	2691 (2.90-2.86)
Clashscore	141614	2947 (2.90-2.86)
Ramachandran outliers	138981	2868 (2.90-2.86)
Sidechain outliers	138945	2871 (2.90-2.86)
RSRZ outliers	127900	2629 (2.90-2.86)

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	128	 3% 79% 6% 15%
2	D	317	 4% 84% 11% 5%
3	B	2	 100%
3	C	2	 50% 50%
3	E	2	 100%

## 2 Entry composition [i](#)

There are 5 unique types of molecules in this entry. The entry contains 3181 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 T-cell surface protein tactile.

Mol	Chain	Residues	Atoms					ZeroOcc	AltConf	Trace
			Total	C	N	O	S			
1	A	109	857	550	138	162	7	0	0	0

There are 10 discrepancies between the modelled and reference sequences:

Chain	Residue	Modelled	Actual	Comment	Reference
A	20	THR	-	expression tag	UNP P40200
A	110	SER	CYS	engineered mutation	UNP P40200
A	140	GLY	-	expression tag	UNP P40200
A	141	THR	-	expression tag	UNP P40200
A	142	HIS	-	expression tag	UNP P40200
A	143	HIS	-	expression tag	UNP P40200
A	144	HIS	-	expression tag	UNP P40200
A	145	HIS	-	expression tag	UNP P40200
A	146	HIS	-	expression tag	UNP P40200
A	147	HIS	-	expression tag	UNP P40200

- Molecule 2 is a protein called Poliovirus receptor.

Mol	Chain	Residues	Atoms					ZeroOcc	AltConf	Trace
			Total	C	N	O	S			
2	D	300	2202	1398	373	421	10	0	0	0

There are 10 discrepancies between the modelled and reference sequences:

Chain	Residue	Modelled	Actual	Comment	Reference
D	26	LEU	-	expression tag	UNP P15151
D	27	GLU	-	expression tag	UNP P15151
D	335	THR	-	expression tag	UNP P15151
D	336	SER	-	expression tag	UNP P15151
D	337	HIS	-	expression tag	UNP P15151
D	338	HIS	-	expression tag	UNP P15151

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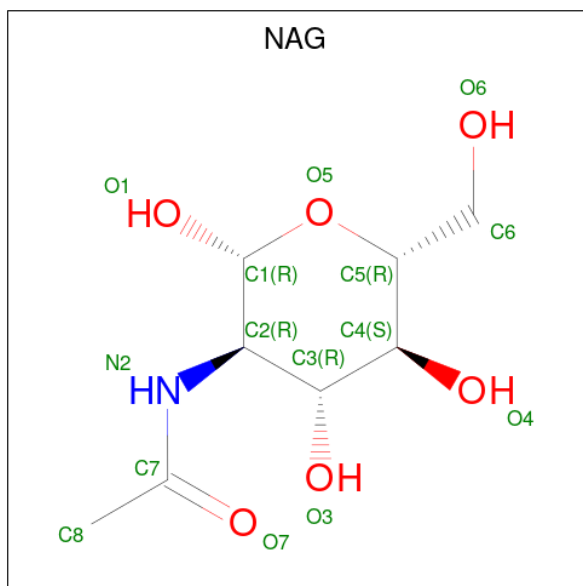
Chain	Residue	Modelled	Actual	Comment	Reference
D	339	HIS	-	expression tag	UNP P15151
D	340	HIS	-	expression tag	UNP P15151
D	341	HIS	-	expression tag	UNP P15151
D	342	HIS	-	expression tag	UNP P15151

- Molecule 3 is an oligosaccharide called alpha-L-fucopyranose-(1-6)-2-acetamido-2-deoxy-beta-D-glucopyranose.



Mol	Chain	Residues	Atoms				ZeroOcc	AltConf	Trace
			Total	C	N	O			
3	B	2	Total	C	N	O	0	0	0
			24	14	1	9			
3	C	2	Total	C	N	O	0	0	0
			24	14	1	9			
3	E	2	Total	C	N	O	0	0	0
			24	14	1	9			

- 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	Total	C	N	O	0	0
			14	8	1	5		

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Mol	Chain	Residues	Atoms				ZeroOcc	AltConf
4	D	1	Total	C	N	O	0	0
			14	8	1	5		
4	D	1	Total	C	N	O	0	0
			14	8	1	5		

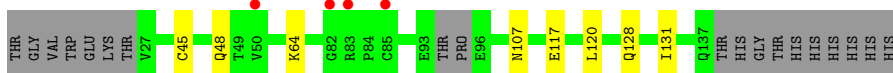
- Molecule 5 is water.

Mol	Chain	Residues	Atoms		ZeroOcc	AltConf
5	A	3	Total	O	0	0
			3	3		
5	D	5	Total	O	0	0
			5	5		

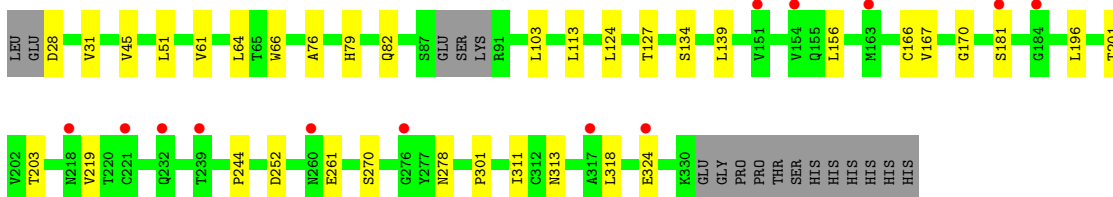
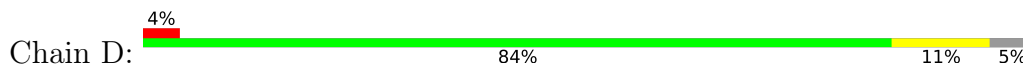
### 3 Residue-property plots [i](#)

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: T-cell surface protein tactile



- Molecule 2: Poliovirus receptor



- Molecule 3: alpha-L-fucopyranose-(1-6)-2-acetamido-2-deoxy-beta-D-glucopyranose



- Molecule 3: alpha-L-fucopyranose-(1-6)-2-acetamido-2-deoxy-beta-D-glucopyranose



- Molecule 3: alpha-L-fucopyranose-(1-6)-2-acetamido-2-deoxy-beta-D-glucopyranose



## 4 Data and refinement statistics

Property	Value	Source
Space group	P 21 21 21	Depositor
Cell constants a, b, c, $\alpha$ , $\beta$ , $\gamma$	33.14Å 70.82Å 224.93Å 90.00° 90.00° 90.00°	Depositor
Resolution (Å)	67.55 – 2.88 67.55 – 2.88	Depositor EDS
% Data completeness (in resolution range)	96.6 (67.55-2.88) 96.7 (67.55-2.88)	Depositor EDS
$R_{merge}$	0.14	Depositor
$R_{sym}$	(Not available)	Depositor
$\langle I/\sigma(I) \rangle$ <sup>1</sup>	1.62 (at 2.86Å)	Xtrriage
Refinement program	BUSTER 2.10.3	Depositor
R, $R_{free}$	0.230 , 0.252 0.263 , 0.283	Depositor DCC
$R_{free}$ test set	592 reflections (4.80%)	wwPDB-VP
Wilson B-factor (Å <sup>2</sup> )	40.7	Xtrriage
Anisotropy	0.331	Xtrriage
Bulk solvent $k_{sol}$ (e/Å <sup>3</sup> ), $B_{sol}$ (Å <sup>2</sup> )	0.29 , 39.5	EDS
L-test for twinning <sup>2</sup>	$\langle  L  \rangle = 0.44$ , $\langle L^2 \rangle = 0.27$	Xtrriage
Estimated twinning fraction	No twinning to report.	Xtrriage
$F_o, F_c$ correlation	0.85	EDS
Total number of atoms	3181	wwPDB-VP
Average B, all atoms (Å <sup>2</sup> )	47.0	wwPDB-VP

Xtrriage's analysis on translational NCS is as follows: *The largest off-origin peak in the Patterson function is 5.25% of the height of the origin peak. No significant pseudotranslation is detected.*

<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](#)

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

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	0.35	0/876	0.56	0/1191
2	D	0.37	0/2257	0.53	0/3109
All	All	0.37	0/3133	0.54	0/4300

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	857	0	815	2	0
2	D	2202	0	2083	14	0
3	B	24	0	22	0	0
3	C	24	0	22	0	0
3	E	24	0	22	0	0
4	A	14	0	13	0	0
4	D	28	0	26	0	0
5	A	3	0	0	0	0
5	D	5	0	0	0	0
All	All	3181	0	3003	16	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 3.

All (16) 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:D:61:VAL:HG22	2:D:127:THR:HG22	1.82	0.62
2:D:170:GLY:H	2:D:201:THR:HG22	1.65	0.60
2:D:124:LEU:HD12	2:D:134:SER:HB3	1.91	0.51
2:D:167:VAL:HG22	2:D:203:THR:HG23	1.97	0.46
2:D:278:ASN:HB3	2:D:313:ASN:HB3	1.98	0.45
1:A:45:CYS:HB3	1:A:120:LEU:HD11	1.99	0.44
2:D:79:HIS:HB3	2:D:82:GLN:HB2	1.99	0.44
2:D:66:TRP:HB2	2:D:76:ALA:HB3	1.99	0.44
2:D:45:VAL:HG11	2:D:139:LEU:HD11	2.00	0.43
2:D:181:SER:HB2	2:D:219:VAL:HG13	2.01	0.43
2:D:244:PRO:HA	2:D:270:SER:HB3	2.00	0.43
2:D:311:ILE:HG12	2:D:324:GLU:HG2	2.00	0.43
1:A:117:GLU:HG3	1:A:131:ILE:HG13	2.02	0.42
2:D:261:GLU:HG2	2:D:301:PRO:HD3	2.02	0.42
2:D:64:LEU:HD21	2:D:103:LEU:HB3	2.02	0.42
2:D:31:VAL:HG22	2:D:51:LEU:HD12	2.03	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	105/128 (82%)	102 (97%)	3 (3%)	0	100	100
2	D	296/317 (93%)	279 (94%)	17 (6%)	0	100	100
All	All	401/445 (90%)	381 (95%)	20 (5%)	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	94/116 (81%)	90 (96%)	4 (4%)	29	60
2	D	234/274 (85%)	227 (97%)	7 (3%)	41	73
All	All	328/390 (84%)	317 (97%)	11 (3%)	37	69

All (11) residues with a non-rotameric sidechain are listed below:

Mol	Chain	Res	Type
1	A	48	GLN
1	A	64	LYS
1	A	107	ASN
1	A	128	GLN
2	D	28	ASP
2	D	113	LEU
2	D	156	LEU
2	D	166	CYS
2	D	196	LEU
2	D	252	ASP
2	D	318	LEU

Sometimes sidechains can be flipped to improve hydrogen bonding and reduce clashes. There are no such sidechains identified.

### 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

6 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
3	NAG	B	1	2,3	14,14,15	0.29	0	17,19,21	0.73	1 (5%)
3	FUC	B	2	3	10,10,11	0.46	0	14,14,16	0.96	1 (7%)
3	NAG	C	1	2,3	14,14,15	0.30	0	17,19,21	0.70	1 (5%)
3	FUC	C	2	3	10,10,11	0.48	0	14,14,16	0.73	0
3	NAG	E	1	2,3	14,14,15	0.42	0	17,19,21	1.64	2 (11%)
3	FUC	E	2	3	10,10,11	0.46	0	14,14,16	0.96	1 (7%)

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	B	1	2,3	-	0/6/23/26	0/1/1/1
3	FUC	B	2	3	-	-	0/1/1/1
3	NAG	C	1	2,3	-	0/6/23/26	0/1/1/1
3	FUC	C	2	3	-	-	0/1/1/1
3	NAG	E	1	2,3	-	1/6/23/26	0/1/1/1
3	FUC	E	2	3	-	-	0/1/1/1

There are no bond length outliers.

All (6) bond angle outliers are listed below:

Mol	Chain	Res	Type	Atoms	Z	Observed(°)	Ideal(°)
3	E	1	NAG	C1-O5-C5	6.00	120.32	112.19
3	E	1	NAG	O5-C1-C2	2.79	115.70	111.29
3	C	1	NAG	C1-O5-C5	2.58	115.69	112.19
3	B	1	NAG	C1-O5-C5	2.43	115.48	112.19
3	B	2	FUC	C1-O5-C5	2.26	117.89	112.78
3	E	2	FUC	C1-O5-C5	2.23	117.83	112.78

There are no chirality outliers.

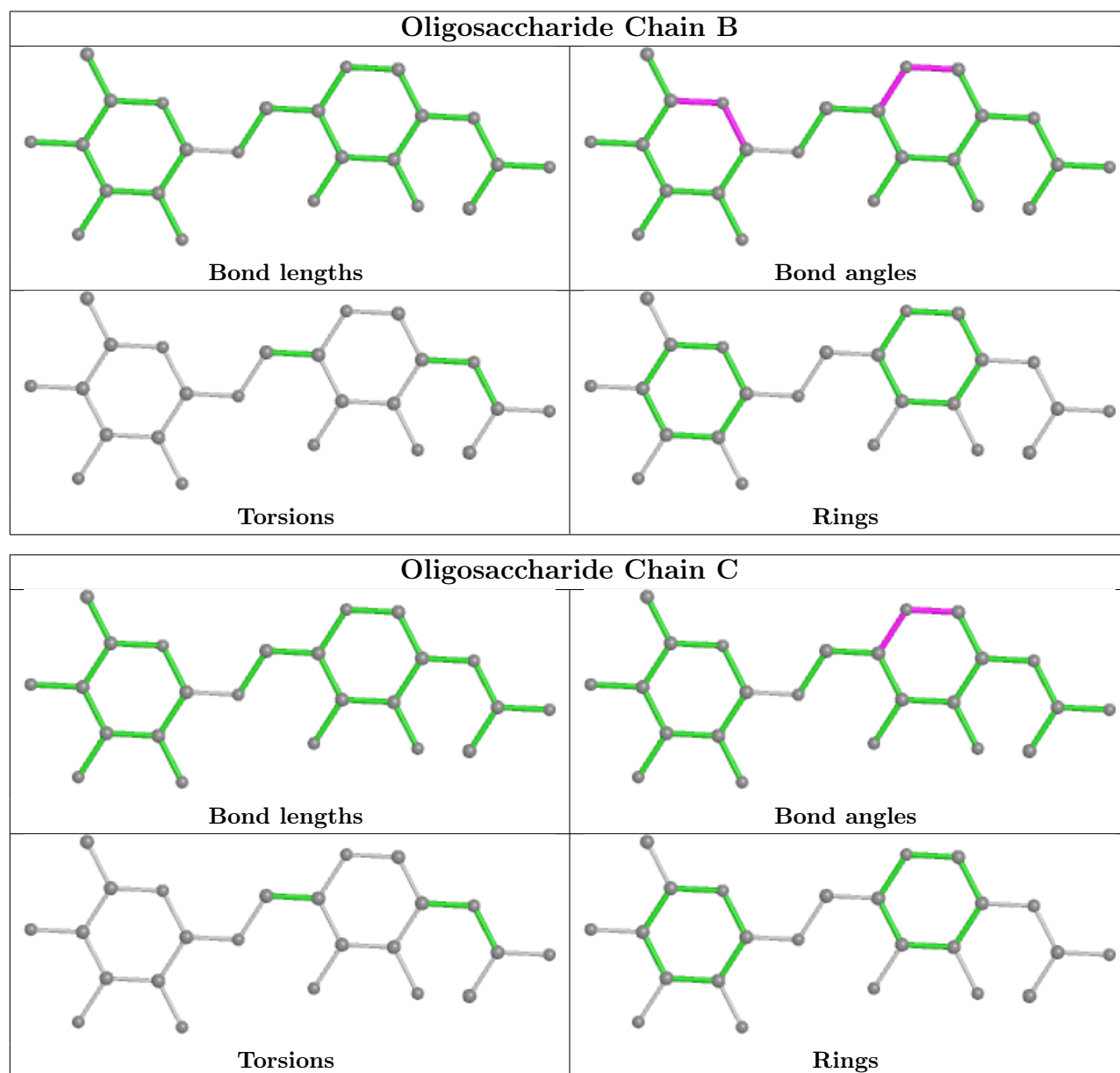
All (1) torsion outliers are listed below:

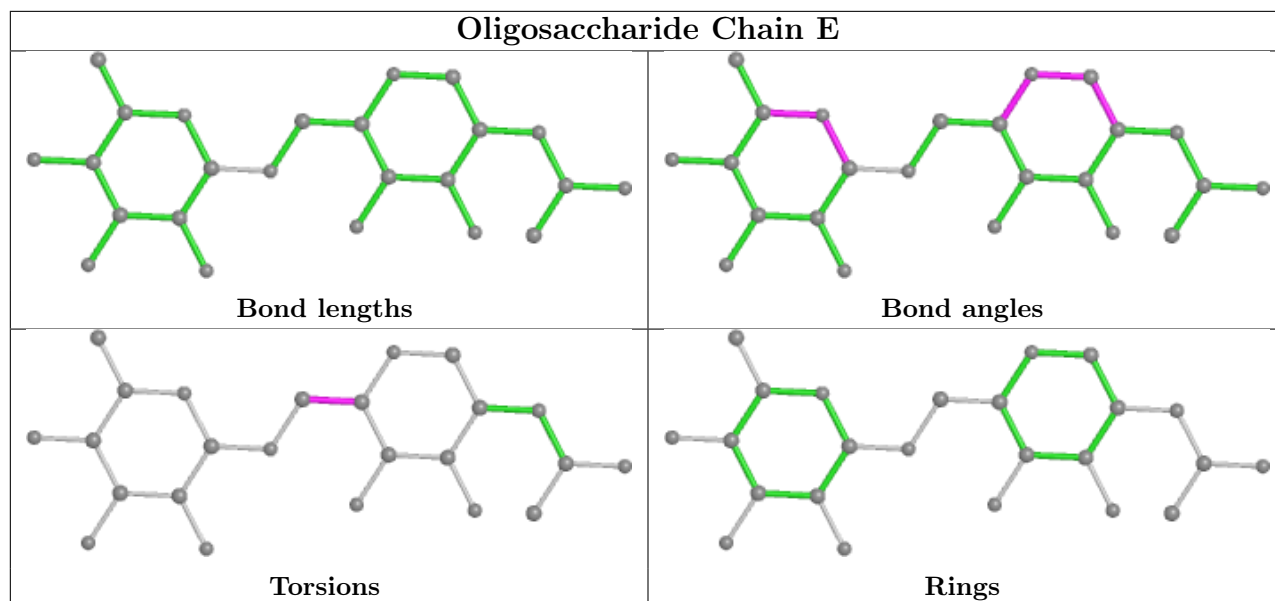
Mol	Chain	Res	Type	Atoms
3	E	1	NAG	O5-C5-C6-O6

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](#)

3 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$
4	NAG	A	201	1	14,14,15	0.29	0	17,19,21	0.64	0
4	NAG	D	407	2	14,14,15	0.29	0	17,19,21	0.91	1 (5%)
4	NAG	D	408	2	14,14,15	0.29	0	17,19,21	0.77	1 (5%)

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	A	201	1	-	0/6/23/26	0/1/1/1
4	NAG	D	407	2	-	0/6/23/26	0/1/1/1
4	NAG	D	408	2	-	0/6/23/26	0/1/1/1

There are no bond length outliers.

All (2) bond angle outliers are listed below:

Mol	Chain	Res	Type	Atoms	Z	Observed(°)	Ideal(°)
4	D	408	NAG	C1-O5-C5	2.47	115.54	112.19
4	D	407	NAG	C1-C2-N2	-2.16	106.80	110.49

There are no chirality outliers.

There are no torsion outliers.

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, 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	109/128 (85%)	0.28	4 (3%) 41 37	14, 34, 56, 77	0
2	D	300/317 (94%)	0.40	13 (4%) 35 31	16, 50, 81, 97	0
All	All	409/445 (91%)	0.36	17 (4%) 36 32	14, 43, 77, 97	0

All (17) RSRZ outliers are listed below:

Mol	Chain	Res	Type	RSRZ
2	D	276	GLY	4.5
2	D	151	VAL	2.8
2	D	232	GLN	2.6
2	D	324	GLU	2.6
1	A	50	VAL	2.5
2	D	260	ASN	2.5
2	D	181	SER	2.5
2	D	154	VAL	2.3
2	D	163	MET	2.3
2	D	317	ALA	2.3
2	D	221	CYS	2.3
1	A	83	ARG	2.3
1	A	82	GLY	2.2
2	D	218	ASN	2.2
1	A	85	CYS	2.2
2	D	239	THR	2.1
2	D	184	GLY	2.1

### 6.2 Non-standard residues in protein, DNA, RNA chains [i](#)

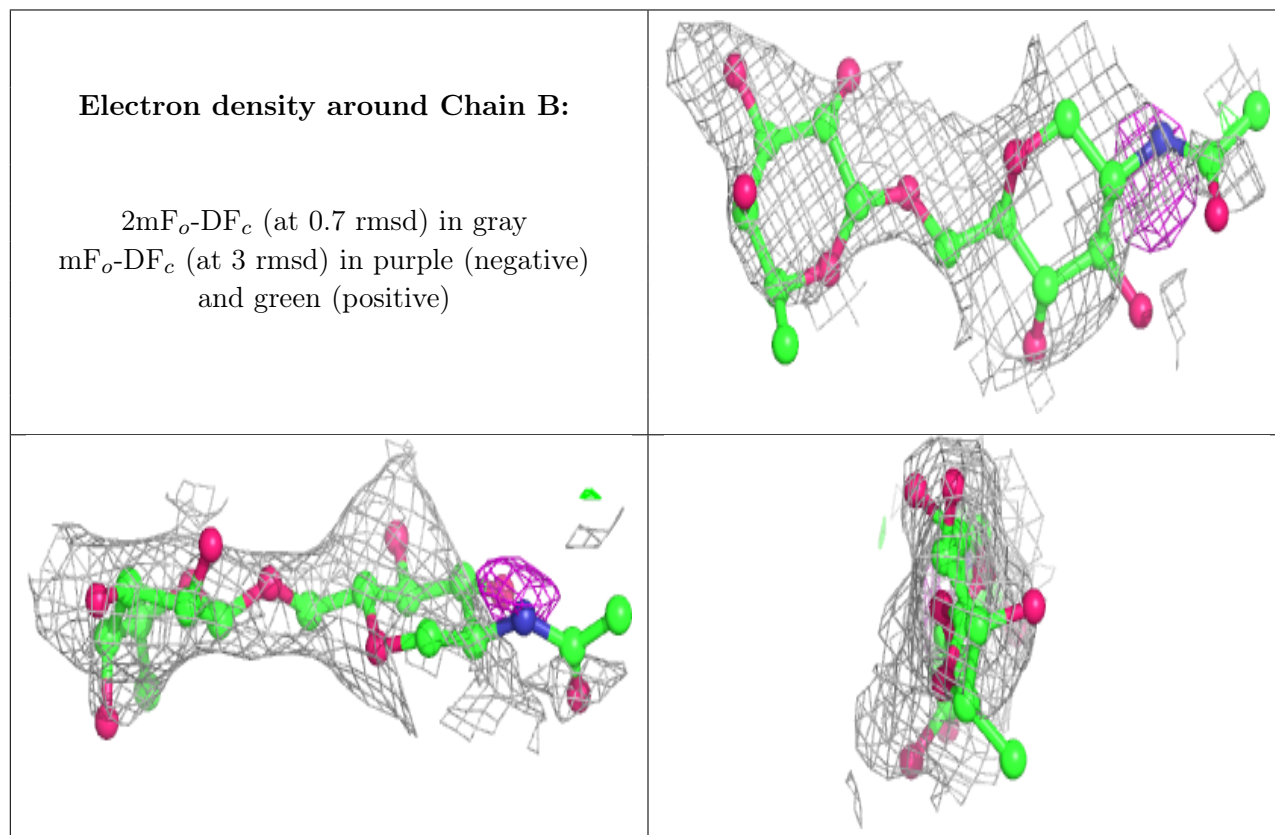
There are no non-standard protein/DNA/RNA residues in this entry.

### 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<sup>th</sup> 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 <sup>2</sup> )	Q<0.9
3	FUC	E	2	10/11	0.58	0.35	99,100,100,100	0
3	NAG	E	1	14/15	0.61	0.28	97,98,100,100	0
3	NAG	B	1	14/15	0.67	0.36	95,98,100,101	0
3	NAG	C	1	14/15	0.73	0.25	60,62,64,66	0
3	FUC	C	2	10/11	0.74	0.28	66,68,70,70	0
3	FUC	B	2	10/11	0.81	0.46	97,98,99,100	0

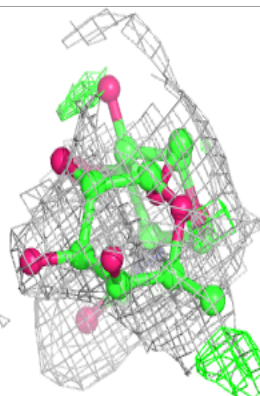
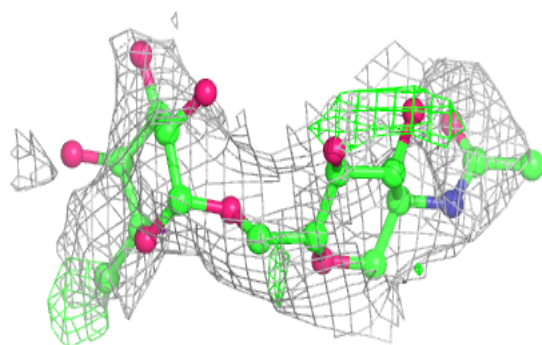
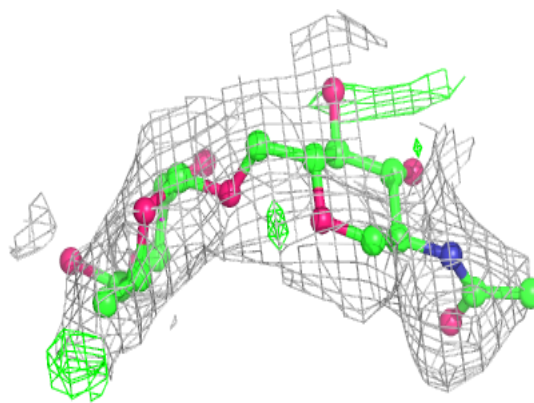
The following is a graphical depiction of the model fit to experimental electron density for oligosaccharide. Each fit is shown from different orientation to approximate a three-dimensional view.



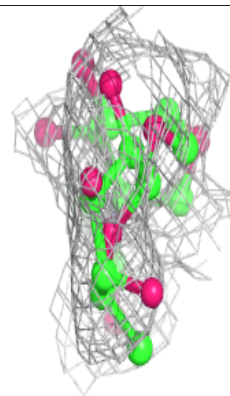
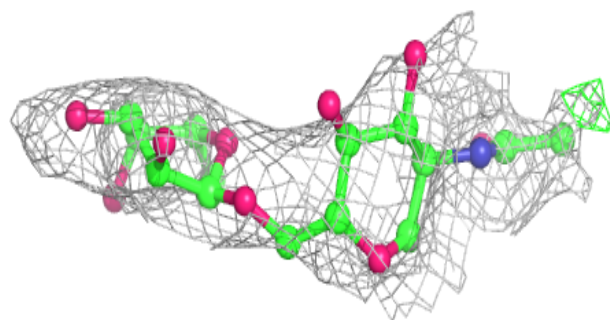
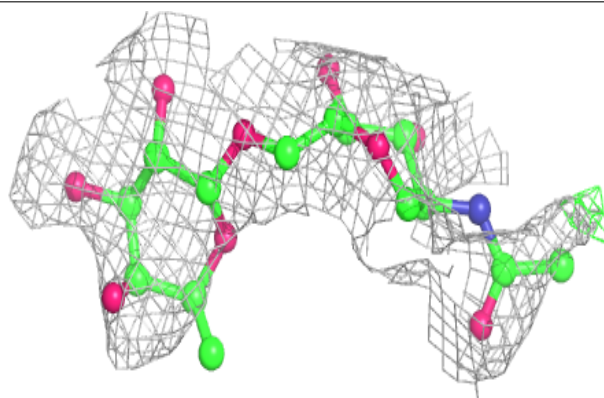


**Electron density around Chain C:**

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

**Electron density around Chain E:**

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



## 6.4 Ligands [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<sup>th</sup> 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 <sup>2</sup> )	Q<0.9
4	NAG	A	201	14/15	0.73	0.31	65,68,69,71	0
4	NAG	D	408	14/15	0.75	0.20	90,91,93,93	0
4	NAG	D	407	14/15	0.76	0.29	58,61,62,63	0

## 6.5 Other polymers [i](#)

There are no such residues in this entry.