Full wwPDB X-ray Structure Validation Report (i)

Dec 13, 2023 – 08:43 am GMT

PDB ID	:	4D6F
Title	:	Crystal structure of a family 98 glycoside hydrolase catalytic module (Sp3GH98) in complex with the type 1 blood group A-tetrasaccharide (E558A, X01 mutant)
Authors	:	Kwan, D.H.; Constantinescu, I.; Chapanian, R.; Higgins, M.A.; Samain, E.; Boraston, A.B.; Kizhakkedathu, J.N.; Withers, S.G.
Deposited on	:	2014-11-11
Resolution	:	2.03 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:

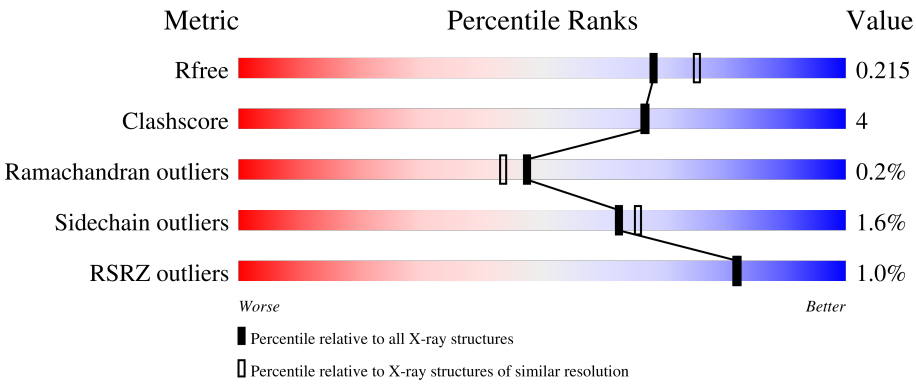
MolProbity	:	4.02b-467
Mogul	:	1.8.4, CSD as541be (2020)
Xtriage (Phenix)	:	1.13
EDS	:	2.36
Percentile statistics	:	20191225.v01 (using entries in the PDB archive December 25th 2019)
Refmac	:	5.8.0158
CCP4	:	7.0.044 (Gargrove)
Ideal geometry (proteins)	:	Engh & Huber (2001)
Ideal geometry (DNA, RNA)	:	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

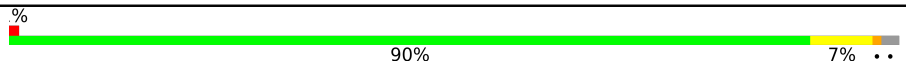
The reported resolution of this entry is 2.03 Å.

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	10434 (2.04-2.00)
Clashscore	141614	11643 (2.04-2.00)
Ramachandran outliers	138981	11493 (2.04-2.00)
Sidechain outliers	138945	11492 (2.04-2.00)
RSRZ outliers	127900	10220 (2.04-2.00)

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	599	
2	B	4	

2 Entry composition (i)

There are 4 unique types of molecules in this entry. The entry contains 5478 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.

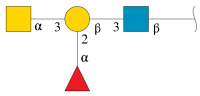
- Molecule 1 is a protein called GLYCOSIDE HYDROLASE.

Mol	Chain	Residues	Atoms					ZeroOcc	AltConf	Trace
			Total	C	N	O	S			
1	A	586	4784	3071	803	897	13	0	2	0

There are 19 discrepancies between the modelled and reference sequences:

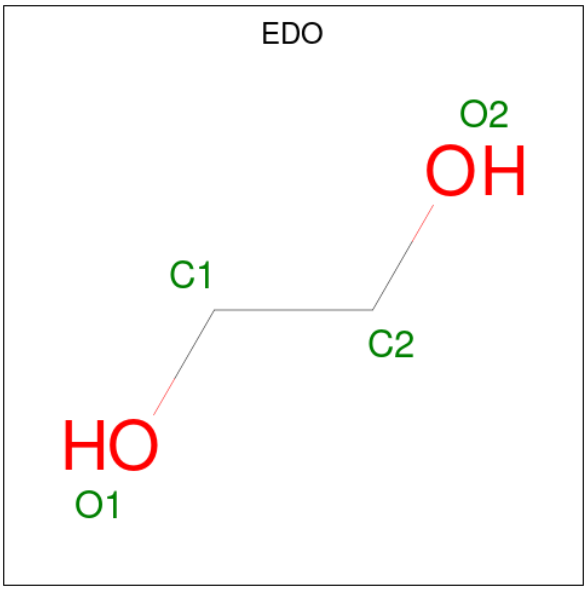
Chain	Residue	Modelled	Actual	Comment	Reference
A	558	ALA	GLU	engineered mutation	UNP A5LBQ0
A	559	SER	ASN	engineered mutation	UNP A5LBQ0
A	592	VAL	ASN	engineered mutation	UNP A5LBQ0
A	1004	LEU	-	expression tag	UNP A5LBQ0
A	1005	GLU	-	expression tag	UNP A5LBQ0
A	1006	HIS	-	expression tag	UNP A5LBQ0
A	1007	THR	-	expression tag	UNP A5LBQ0
A	1008	ARG	-	expression tag	UNP A5LBQ0
A	1009	ALA	-	expression tag	UNP A5LBQ0
A	1010	PRO	-	expression tag	UNP A5LBQ0
A	1011	PRO	-	expression tag	UNP A5LBQ0
A	1012	PRO	-	expression tag	UNP A5LBQ0
A	1013	PRO	-	expression tag	UNP A5LBQ0
A	1014	PRO	-	expression tag	UNP A5LBQ0
A	1015	LEU	-	expression tag	UNP A5LBQ0
A	1016	ARG	-	expression tag	UNP A5LBQ0
A	1017	SER	-	expression tag	UNP A5LBQ0
A	1018	GLY	-	expression tag	UNP A5LBQ0
A	1019	CYS	-	expression tag	UNP A5LBQ0

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



Mol	Chain	Residues	Atoms				ZeroOcc	AltConf	Trace
			Total	C	N	O			
2	B	4	50	28	2	20	0	0	0

- Molecule 3 is 1,2-ETHANEDIOL (three-letter code: EDO) (formula: $C_2H_6O_2$).



Mol	Chain	Residues	Atoms				ZeroOcc	AltConf
			Total	C	O			
3	A	1	4	2	2		0	0
			Total	C	O			
3	A	1	4	2	2		0	0

- Molecule 4 is water.

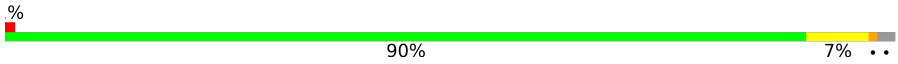
Mol	Chain	Residues	Atoms		ZeroOcc	AltConf
			Total	O		
4	A	636	636	636	0	0

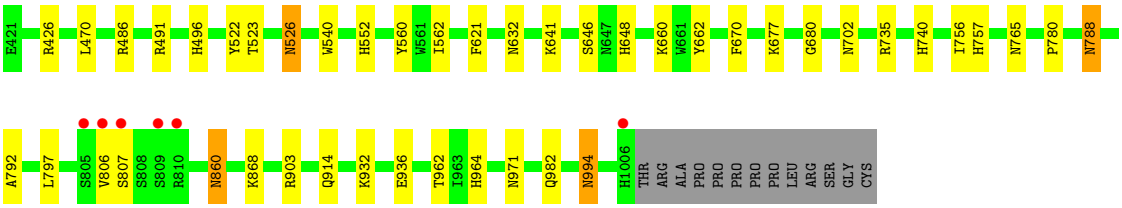
3 Residue-property plots (i)

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: GLYCOSIDE HYDROLASE

Chain A:





• Molecule 2: alpha-L-fucopyranose-(1-2)-[2-acetamido-2-deoxy-alpha-D-galactopyranose-(1-3)]beta-D-galactopyranose-(1-3)-2-acetamido-2-deoxy-beta-D-glucopyranose

Chain B:

4 Data and refinement statistics (i)

Property	Value	Source
Space group	C 2 2 21	Depositor
Cell constants a, b, c, α, β, γ	92.16Å 154.78Å 97.26Å 90.00° 90.00° 90.00°	Depositor
Resolution (Å)	30.28 – 2.03 30.28 – 2.03	Depositor EDS
% Data completeness (in resolution range)	97.3 (30.28-2.03) 97.3 (30.28-2.03)	Depositor EDS
R_{merge}	0.14	Depositor
R_{sym}	(Not available)	Depositor
$< I/\sigma(I) >$ [1]	2.76 (at 2.03Å)	Xtriage
Refinement program	REFMAC 5.5.0109	Depositor
R, R_{free}	0.167 , 0.215 0.167 , 0.215	Depositor DCC
R_{free} test set	2224 reflections (5.05%)	wwPDB-VP
Wilson B-factor (Å^2)	15.9	Xtriage
Anisotropy	0.048	Xtriage
Bulk solvent k_{sol}(e/Å^3), B_{sol}(Å^2)	0.34 , 49.5	EDS
L-test for twinning[2]	$< \|L\| > = 0.48$, $< L^2 > = 0.31$	Xtriage
Estimated twinning fraction	0.020 for 1/2*h-1/2*k,-3/2*h-1/2*k,-l 0.028 for 1/2*h+1/2*k,3/2*h-1/2*k,-l	Xtriage
F_o,F_c correlation	0.95	EDS
Total number of atoms	5478	wwPDB-VP
Average B, all atoms (Å^2)	14.0	wwPDB-VP

Xtriage's analysis on translational NCS is as follows: *The largest off-origin peak in the Patterson function is 4.44% 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: GAL, NAG, A2G, FUC, EDO

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	0.51	0/4918	0.57	0/6666

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	4784	0	4610	33	1
2	B	50	0	45	5	0
3	A	8	0	12	1	0
4	A	636	0	0	7	2
All	All	5478	0	4667	36	2

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 4.

All (36) 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:A:426:ARG:HH11	1:A:552:HIS:HD2	1.27	0.81
1:A:903:ARG:H	1:A:994:ASN:HD21	1.28	0.79
1:A:670:PHE:H	1:A:860:ASN:ND2	1.86	0.73
1:A:560:TYR:OH	2:B:1:NAG:H81	1.88	0.72
1:A:670:PHE:H	1:A:860:ASN:HD21	1.36	0.71
1:A:646:SER:OG	1:A:648:HIS:HD2	1.84	0.61
1:A:962:THR:OG1	1:A:964:HIS:HE1	1.87	0.57
1:A:903:ARG:H	1:A:994:ASN:ND2	2.01	0.57
1:A:740:HIS:HE1	4:A:3366:HOH:O	1.90	0.53
4:A:3317:HOH:O	2:B:4:A2G:H8B	2.08	0.53
1:A:932:LYS:HE2	1:A:936:GLU:OE2	2.10	0.52
1:A:641:LYS:NZ	1:A:702:ASN:HD22	2.07	0.52
1:A:522:TYR:HA	1:A:526:ASN:ND2	2.26	0.51
1:A:522:TYR:HA	1:A:526:ASN:HD21	1.77	0.50
1:A:702:ASN:HD21	1:A:788:ASN:HB2	1.77	0.49
1:A:662:TYR:CD1	1:A:680:GLY:HA2	2.48	0.48
1:A:560:TYR:OH	2:B:1:NAG:C8	2.61	0.48
1:A:662:TYR:CZ	1:A:677:LYS:HB3	2.49	0.48
1:A:426:ARG:HH11	1:A:552:HIS:CD2	2.17	0.48
1:A:491:ARG:HD2	1:A:540:TRP:CD1	2.50	0.46
1:A:632:ASN:ND2	1:A:765:ASN:HB3	2.31	0.46
1:A:486:ARG:CZ	3:A:2012:EDO:H11	2.46	0.46
1:A:971:ASN:ND2	4:A:3598:HOH:O	2.45	0.45
1:A:757:HIS:CE1	1:A:797:LEU:O	2.71	0.44
2:B:2:GAL:C3	2:B:4:A2G:C1	2.87	0.44
1:A:868:LYS:NZ	4:A:3483:HOH:O	2.37	0.43
2:B:2:GAL:O3	2:B:4:A2G:C2	2.62	0.43
1:A:660:LYS:HE2	1:A:780:PRO:HG3	2.02	0.42
1:A:648:HIS:HE1	4:A:3271:HOH:O	2.02	0.42
1:A:994:ASN:HD22	1:A:994:ASN:C	2.23	0.41
1:A:641:LYS:HZ1	1:A:702:ASN:HD22	1.69	0.41
1:A:470:LEU:HD21	1:A:735:ARG:HG3	2.03	0.41
1:A:523:THR:H	1:A:526:ASN:ND2	2.19	0.40
1:A:552:HIS:HE1	4:A:3159:HOH:O	2.04	0.40
1:A:756:ILE:O	1:A:792:ALA:HA	2.21	0.40
1:A:496:HIS:HE1	4:A:3116:HOH:O	2.05	0.40

All (2) 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)
4:A:3146:HOH:O	4:A:3534:HOH:O[8_445]	1.86	0.34

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Atom-1	Atom-2	Interatomic distance (Å)	Clash overlap (Å)
1:A:914:GLN:OE1	4:A:3232:HOH:O[6_445]	2.17	0.03

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	586/599 (98%)	562 (96%)	23 (4%)	1 (0%)	47 43

All (1) Ramachandran outliers are listed below:

Mol	Chain	Res	Type
1	A	562	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	A	512/526 (97%)	504 (98%)	8 (2%)	62 66

All (8) residues with a non-rotameric sidechain are listed below:

Mol	Chain	Res	Type
1	A	526	ASN
1	A	621	PHE
1	A	788	ASN
1	A	806	VAL

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Mol	Chain	Res	Type
1	A	807	SER
1	A	860	ASN
1	A	982	GLN
1	A	994	ASN

Sometimes sidechains can be flipped to improve hydrogen bonding and reduce clashes. All (21) such sidechains are listed below:

Mol	Chain	Res	Type
1	A	496	HIS
1	A	512	ASN
1	A	526	ASN
1	A	552	HIS
1	A	581	ASN
1	A	609	GLN
1	A	618	ASN
1	A	632	ASN
1	A	648	HIS
1	A	702	ASN
1	A	740	HIS
1	A	757	HIS
1	A	788	ASN
1	A	860	ASN
1	A	898	ASN
1	A	917	ASN
1	A	924	GLN
1	A	964	HIS
1	A	971	ASN
1	A	992	ASN
1	A	994	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)

4 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	$\#\|Z\| > 2$
2	NAG	B	1	2	15,15,15	0.46	0	21,21,21	1.34	3 (14%)
2	GAL	B	2	2	11,11,12	0.66	0	15,15,17	2.58	6 (40%)
2	FUC	B	3	2	10,10,11	0.67	0	14,14,16	0.72	0
2	A2G	B	4	2	14,14,15	0.71	0	17,19,21	1.83	2 (11%)

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
2	NAG	B	1	2	-	2/6/26/26	0/1/1/1
2	GAL	B	2	2	-	0/2/19/22	0/1/1/1
2	FUC	B	3	2	-	-	0/1/1/1
2	A2G	B	4	2	-	3/6/23/26	0/1/1/1

There are no bond length outliers.

All (11) bond angle outliers are listed below:

Mol	Chain	Res	Type	Atoms	Z	Observed(^{o})	Ideal(^{o})
2	B	2	GAL	C1-O5-C5	6.99	121.67	112.19
2	B	4	A2G	O5-C1-C2	5.78	120.42	111.29
2	B	2	GAL	C1-C2-C3	4.27	114.91	109.67
2	B	1	NAG	O5-C1-C2	3.51	113.05	109.52
2	B	4	A2G	C1-C2-N2	-3.46	104.57	110.49
2	B	2	GAL	C2-C3-C4	2.47	115.17	110.89
2	B	2	GAL	O5-C1-C2	2.26	114.26	110.77
2	B	2	GAL	O3-C3-C2	-2.22	105.74	109.99
2	B	2	GAL	O4-C4-C5	2.18	114.71	109.30
2	B	1	NAG	C1-C2-C3	2.13	113.44	110.54

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Mol	Chain	Res	Type	Atoms	Z	Observed(^{o})	Ideal(^{o})
2	B	1	NAG	C4-C3-C2	-2.12	107.24	110.34

There are no chirality outliers.

All (5) torsion outliers are listed below:

Mol	Chain	Res	Type	Atoms
2	B	1	NAG	C8-C7-N2-C2
2	B	1	NAG	O7-C7-N2-C2
2	B	4	A2G	O7-C7-N2-C2
2	B	4	A2G	C8-C7-N2-C2
2	B	4	A2G	O5-C5-C6-O6

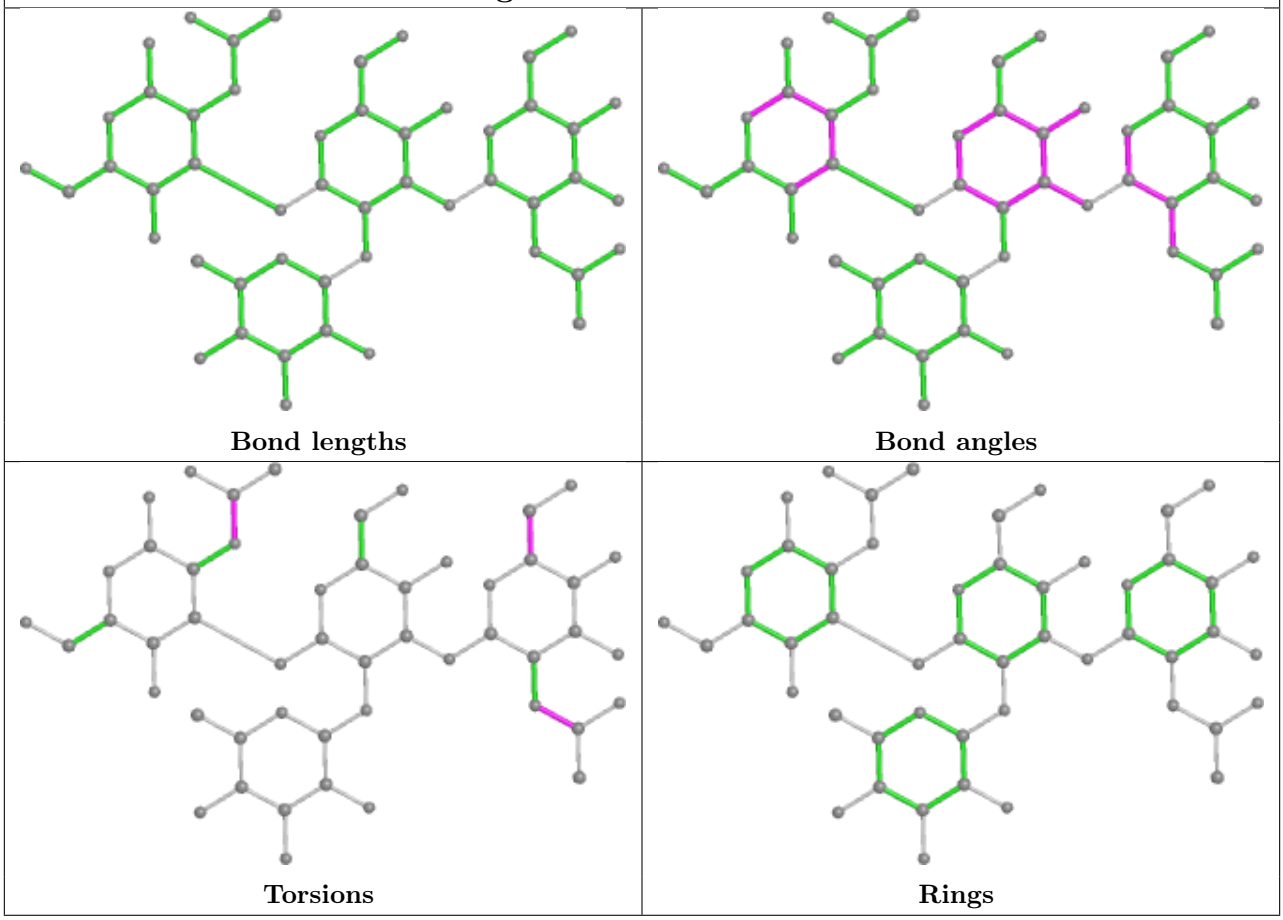
There are no ring outliers.

3 monomers are involved in 5 short contacts:

Mol	Chain	Res	Type	Clashes	Symm-Clashes
2	B	4	A2G	3	0
2	B	1	NAG	2	0
2	B	2	GAL	2	0

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

Oligosaccharide Chain B



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	EDO	A	2011	-	3,3,3	0.50	0	2,2,2	0.24	0
3	EDO	A	2012	-	3,3,3	0.51	0	2,2,2	0.20	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	EDO	A	2011	-	-	1/1/1/1	-
3	EDO	A	2012	-	-	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
3	A	2011	EDO	O1-C1-C2-O2

There are no ring outliers.

1 monomer is involved in 1 short contact:

Mol	Chain	Res	Type	Clashes	Symm-Clashes
3	A	2012	EDO	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	586/599 (97%)	-0.14	6 (1%) 82 82	6, 12, 24, 45	8 (1%)

All (6) RSRZ outliers are listed below:

Mol	Chain	Res	Type	RSRZ
1	A	806	VAL	6.6
1	A	807	SER	4.8
1	A	809	SER	3.6
1	A	805	SER	3.2
1	A	1006	HIS	2.8
1	A	810	ARG	2.4

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)

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.

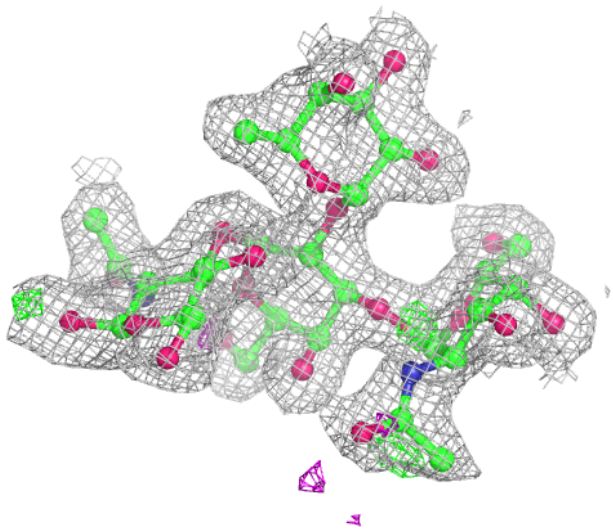
Mol	Type	Chain	Res	Atoms	RSCC	RSR	B-factors(Å^2)	Q<0.9
2	A2G	B	4	14/15	0.92	0.12	9,11,23,27	0
2	NAG	B	1	15/15	0.94	0.13	15,18,21,23	0
2	GAL	B	2	11/12	0.96	0.10	10,11,12,13	0
2	FUC	B	3	10/11	0.97	0.10	10,11,12,12	0

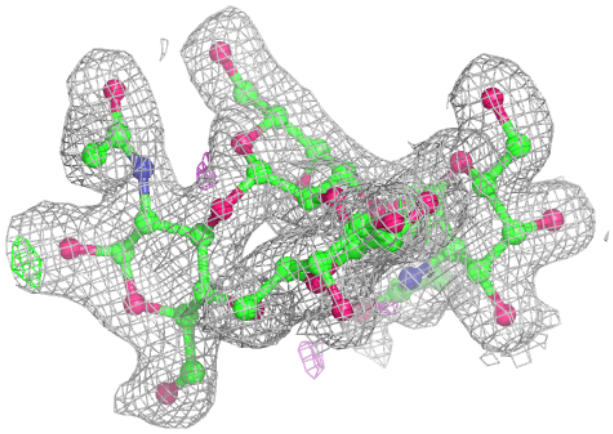
The following is a graphical depiction of the model fit to experimental electron density for oligosac-

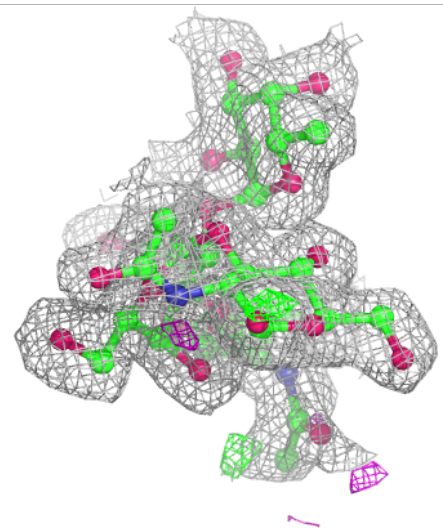
charide. Each fit is shown from different orientation to approximate a three-dimensional view.

Electron density around Chain B:

$2mF_o$-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, 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	EDO	A	2012	4/4	0.80	0.21	26,27,28,28	0
3	EDO	A	2011	4/4	0.98	0.12	10,11,11,13	0

6.5 Other polymers (i)

There are no such residues in this entry.