wwPDB X-ray Structure Validation Summary Report (i)

Dec 10, 2023 – 01:00 AM JST

PDB ID	:	8IBT
Title	:	Crystal structure of GH42 beta-galactosidase BiBga42A from Bifidobacterium longum subspecies infantis E318S mutant in complex with lacto-N-tetraose
Authors	:	Hidaka, M.; Fushinobu, S.; Gotoh, A.; Katayama, T.
Deposited on	:	2023-02-10
Resolution	:	2.20 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 (1)) were used in the production of this report:

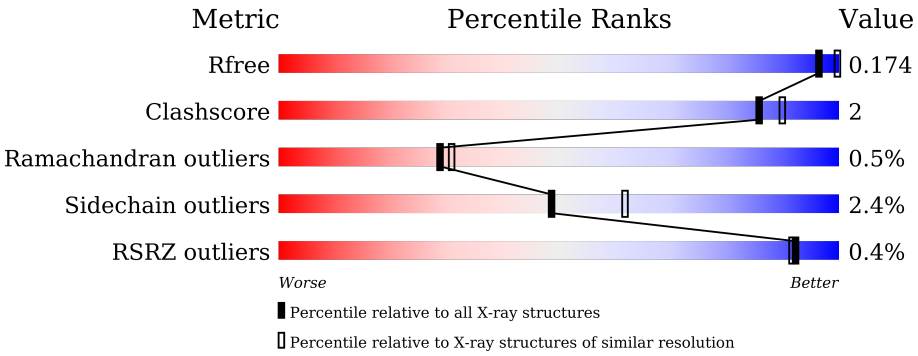
MolProbity	:	4.02b-467
Mogul	:	1.8.5 (274361), CSD as541be (2020)
Xtriage (Phenix)	:	1.13
EDS	:	2.36
Percentile statistics	:	20191225.v01 (using entries in the PDB archive December 25th 2019)
Refmac	:	5.8.0158
CCP4	:	7.0.044 (Gargrove)
Ideal geometry (proteins)	:	Engh & Huber (2001)
Ideal geometry (DNA, 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 2.20 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	4898 (2.20-2.20)
Clashscore	141614	5594 (2.20-2.20)
Ramachandran outliers	138981	5503 (2.20-2.20)
Sidechain outliers	138945	5504 (2.20-2.20)
RSRZ outliers	127900	4800 (2.20-2.20)

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	702	91% 7% ••
1	B	702	92% 7% •
2	C	4	25% 75%
2	D	4	25% 75%

2 Entry composition (i)

There are 3 unique types of molecules in this entry. The entry contains 11711 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.

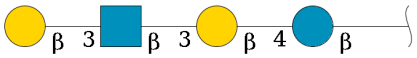
- Molecule 1 is a protein called Beta-galactosidase.

Mol	Chain	Residues	Atoms					ZeroOcc	AltConf	Trace
1	A	694	Total	C	N	O	S	0	0	0
			5486	3489	937	1038	22			
1	B	693	Total	C	N	O	S	0	0	0
			5479	3483	936	1038	22			

There are 24 discrepancies between the modelled and reference sequences:

Chain	Residue	Modelled	Actual	Comment	Reference
A	318	SER	GLU	engineered mutation	UNP B7GUD7
A	692	ALA	-	expression tag	UNP B7GUD7
A	693	ALA	-	expression tag	UNP B7GUD7
A	694	ALA	-	expression tag	UNP B7GUD7
A	695	LEU	-	expression tag	UNP B7GUD7
A	696	GLU	-	expression tag	UNP B7GUD7
A	697	HIS	-	expression tag	UNP B7GUD7
A	698	HIS	-	expression tag	UNP B7GUD7
A	699	HIS	-	expression tag	UNP B7GUD7
A	700	HIS	-	expression tag	UNP B7GUD7
A	701	HIS	-	expression tag	UNP B7GUD7
A	702	HIS	-	expression tag	UNP B7GUD7
B	318	SER	GLU	engineered mutation	UNP B7GUD7
B	692	ALA	-	expression tag	UNP B7GUD7
B	693	ALA	-	expression tag	UNP B7GUD7
B	694	ALA	-	expression tag	UNP B7GUD7
B	695	LEU	-	expression tag	UNP B7GUD7
B	696	GLU	-	expression tag	UNP B7GUD7
B	697	HIS	-	expression tag	UNP B7GUD7
B	698	HIS	-	expression tag	UNP B7GUD7
B	699	HIS	-	expression tag	UNP B7GUD7
B	700	HIS	-	expression tag	UNP B7GUD7
B	701	HIS	-	expression tag	UNP B7GUD7
B	702	HIS	-	expression tag	UNP B7GUD7

- Molecule 2 is an oligosaccharide called beta-D-galactopyranose-(1-3)-2-acetamido-2-deoxy-beta-D-glucopyranose-(1-3)-beta-D-galactopyranose-(1-4)-beta-D-glucopyranose.



Mol	Chain	Residues	Atoms				ZeroOcc	AltConf	Trace
2	C	4	Total	C	N	O	0	0	0
			48	26	1	21			
2	D	4	Total	C	N	O	0	0	0
			48	26	1	21			

- Molecule 3 is water.

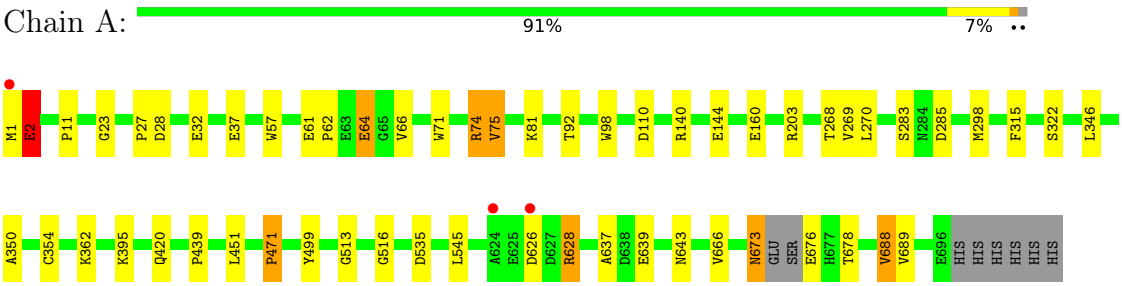
Mol	Chain	Residues	Atoms		ZeroOcc	AltConf
3	A	346	Total	O	0	0
			346	346		
3	B	304	Total	O	0	0
			304	304		

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.

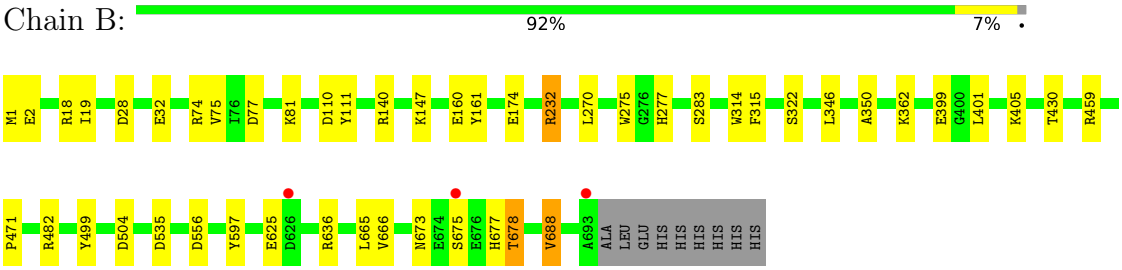
• Molecule 1: Beta-galactosidase

Chain A:



• Molecule 1: Beta-galactosidase

Chain B:



• Molecule 2: beta-D-galactopyranose-(1-3)-2-acetamido-2-deoxy-beta-D-glucopyranose-(1-3)-beta-D-galactopyranose-(1-4)-beta-D-glucopyranose

Chain C:

• Molecule 2: beta-D-galactopyranose-(1-3)-2-acetamido-2-deoxy-beta-D-glucopyranose-(1-3)-beta-D-galactopyranose-(1-4)-beta-D-glucopyranose

Chain D:

4 Data and refinement statistics (i)

Property	Value	Source
Space group	P 3 2 1	Depositor
Cell constants a, b, c, α, β, γ	166.43Å 166.43Å 149.46Å 90.00° 90.00° 120.00°	Depositor
Resolution (Å)	48.04 – 2.20 48.04 – 2.20	Depositor EDS
% Data completeness (in resolution range)	100.0 (48.04-2.20) 99.9 (48.04-2.20)	Depositor EDS
R_{merge}	0.12	Depositor
R_{sym}	(Not available)	Depositor
$< I/\sigma(I) >$ [1]	3.52 (at 2.20Å)	Xtriage
Refinement program	REFMAC 5.8.0403	Depositor
R, R_{free}	0.146 , 0.175 0.151 , 0.174	Depositor DCC
R_{free} test set	6036 reflections (4.99%)	wwPDB-VP
Wilson B-factor (Å^2)	29.2	Xtriage
Anisotropy	0.028	Xtriage
Bulk solvent k_{sol}(e/Å^3), B_{sol}(Å^2)	0.34 , 30.0	EDS
L-test for twinning[2]	$< \|L\| > = 0.52$, $< L^2 > = 0.36$	Xtriage
Estimated twinning fraction	0.000 for -h,-k,l	Xtriage
F_o,F_c correlation	0.96	EDS
Total number of atoms	11711	wwPDB-VP
Average B, all atoms (Å^2)	30.0	wwPDB-VP

Xtriage's analysis on translational NCS is as follows: *The largest off-origin peak in the Patterson function is 3.10% 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: GAL, BGC, 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	0.64	3/5644 (0.1%)	0.93	5/7697 (0.1%)
1	B	0.61	1/5638 (0.0%)	0.93	4/7690 (0.1%)
All	All	0.63	4/11282 (0.0%)	0.93	9/15387 (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
1	A	0	1
1	B	0	3
All	All	0	4

All (4) bond length outliers are listed below:

Mol	Chain	Res	Type	Atoms	Z	Observed(Å)	Ideal(Å)
1	A	64	GLU	CD-OE1	-7.22	1.17	1.25
1	A	37	GLU	CD-OE1	5.84	1.32	1.25
1	B	174	GLU	CD-OE1	-5.68	1.19	1.25
1	A	144	GLU	CD-OE1	5.59	1.31	1.25

The worst 5 of 9 bond angle outliers are listed below:

Mol	Chain	Res	Type	Atoms	Z	Observed(^{o})	Ideal(^{o})
1	A	535	ASP	CB-CA-C	-6.88	96.63	110.40
1	A	140	ARG	NE-CZ-NH2	-6.63	116.98	120.30
1	B	232	ARG	NE-CZ-NH2	-6.55	117.02	120.30
1	A	74	ARG	NE-CZ-NH1	-6.06	117.27	120.30
1	B	140	ARG	NE-CZ-NH2	-5.75	117.43	120.30

There are no chirality outliers.

All (4) planarity outliers are listed below:

Mol	Chain	Res	Type	Group
1	A	203	ARG	Sidechain
1	B	459	ARG	Sidechain
1	B	482	ARG	Sidechain
1	B	675	SER	Peptide

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	5486	0	5190	31	0
1	B	5479	0	5180	17	0
2	C	48	0	42	0	0
2	D	48	0	41	0	0
3	A	346	0	0	7	0
3	B	304	0	0	1	0
All	All	11711	0	10453	48	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 2.

The worst 5 of 48 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:626:ASP:HB2	3:A:873:HOH:O	1.63	0.98
1:A:666:VAL:HB	1:A:688:VAL:HG13	1.83	0.61
1:B:32:GLU:CD	1:B:74:ARG:HH12	2.04	0.60
1:A:1:MET:O	1:A:2:GLU:CB	2.50	0.60
1:A:673:ASN:ND2	1:A:676:GLU:HB3	2.17	0.59

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	690/702 (98%)	669 (97%)	17 (2%)	4 (1%)	25	26
1	B	691/702 (98%)	664 (96%)	24 (4%)	3 (0%)	34	37
All	All	1381/1404 (98%)	1333 (96%)	41 (3%)	7 (0%)	29	31

5 of 7 Ramachandran outliers are listed below:

Mol	Chain	Res	Type
1	B	2	GLU
1	A	628	ARG
1	A	2	GLU
1	A	322	SER
1	A	471	PRO

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	568/576 (99%)	553 (97%)	15 (3%)	46	58
1	B	568/576 (99%)	556 (98%)	12 (2%)	53	67
All	All	1136/1152 (99%)	1109 (98%)	27 (2%)	49	62

5 of 27 residues with a non-rotameric sidechain are listed below:

Mol	Chain	Res	Type
1	A	689	VAL

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Mol	Chain	Res	Type
1	B	110	ASP
1	B	677	HIS
1	B	75	VAL
1	B	111	TYR

Sometimes sidechains can be flipped to improve hydrogen bonding and reduce clashes. All (1) such sidechains are listed below:

Mol	Chain	Res	Type
1	A	673	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)

8 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	BGC	C	1	2	12,12,12	0.55	0	17,17,17	1.01	0
2	GAL	C	2	2	11,11,12	1.21	1 (9%)	15,15,17	1.49	4 (26%)
2	NAG	C	3	2	14,14,15	0.63	0	17,19,21	1.73	3 (17%)
2	GAL	C	4	2	11,11,12	0.87	1 (9%)	15,15,17	1.82	5 (33%)
2	BGC	D	1	2	12,12,12	0.50	0	17,17,17	0.77	0
2	GAL	D	2	2	11,11,12	1.07	1 (9%)	15,15,17	1.47	2 (13%)
2	NAG	D	3	2	14,14,15	0.66	0	17,19,21	1.45	3 (17%)

Mol	Type	Chain	Res	Link	Bond lengths			Bond angles		
					Counts	RMSZ	$\#\|Z\|>2$	Counts	RMSZ	$\#\|Z\|>2$
2	GAL	D	4	2	11,11,12	1.15	1 (9%)	15,15,17	2.01	6 (40%)

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	BGC	C	1	2	-	0/2/22/22	0/1/1/1
2	GAL	C	2	2	-	2/2/19/22	0/1/1/1
2	NAG	C	3	2	-	1/6/23/26	0/1/1/1
2	GAL	C	4	2	-	0/2/19/22	0/1/1/1
2	BGC	D	1	2	-	0/2/22/22	0/1/1/1
2	GAL	D	2	2	-	1/2/19/22	0/1/1/1
2	NAG	D	3	2	-	1/6/23/26	0/1/1/1
2	GAL	D	4	2	-	0/2/19/22	0/1/1/1

All (4) bond length outliers are listed below:

Mol	Chain	Res	Type	Atoms	Z	Observed(Å)	Ideal(Å)
2	C	2	GAL	C2-C3	-3.52	1.47	1.52
2	D	2	GAL	O5-C5	2.56	1.48	1.43
2	D	4	GAL	C2-C3	2.47	1.56	1.52
2	C	4	GAL	C2-C3	2.18	1.55	1.52

The worst 5 of 23 bond angle outliers are listed below:

Mol	Chain	Res	Type	Atoms	Z	Observed(^{o})	Ideal(^{o})
2	D	4	GAL	C1-C2-C3	4.54	115.25	109.67
2	C	3	NAG	C1-C2-N2	4.28	117.80	110.49
2	C	4	GAL	C1-C2-C3	3.72	114.23	109.67
2	C	3	NAG	O3-C3-C2	-3.69	101.84	109.47
2	D	3	NAG	C1-C2-N2	3.36	116.23	110.49

There are no chirality outliers.

All (5) torsion outliers are listed below:

Mol	Chain	Res	Type	Atoms
2	C	3	NAG	C1-C2-N2-C7
2	D	3	NAG	C1-C2-N2-C7
2	C	2	GAL	O5-C5-C6-O6

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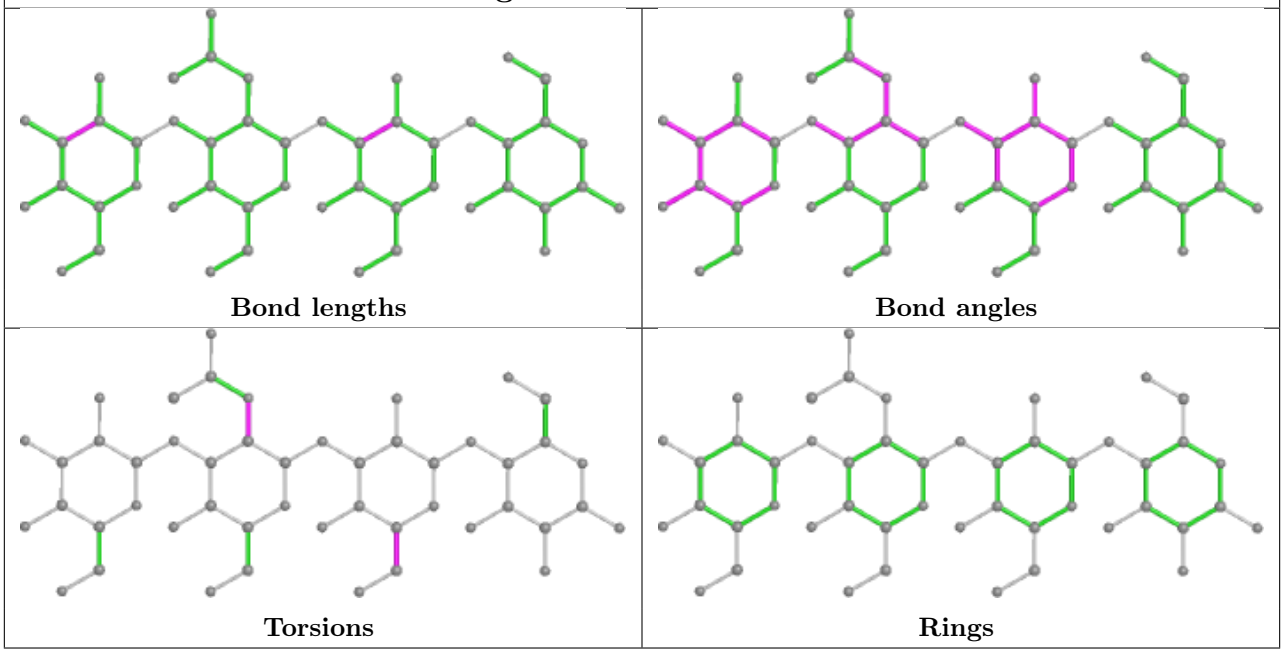
Mol	Chain	Res	Type	Atoms
2	C	2	GAL	C4-C5-C6-O6
2	D	2	GAL	O5-C5-C6-O6

There are no ring outliers.

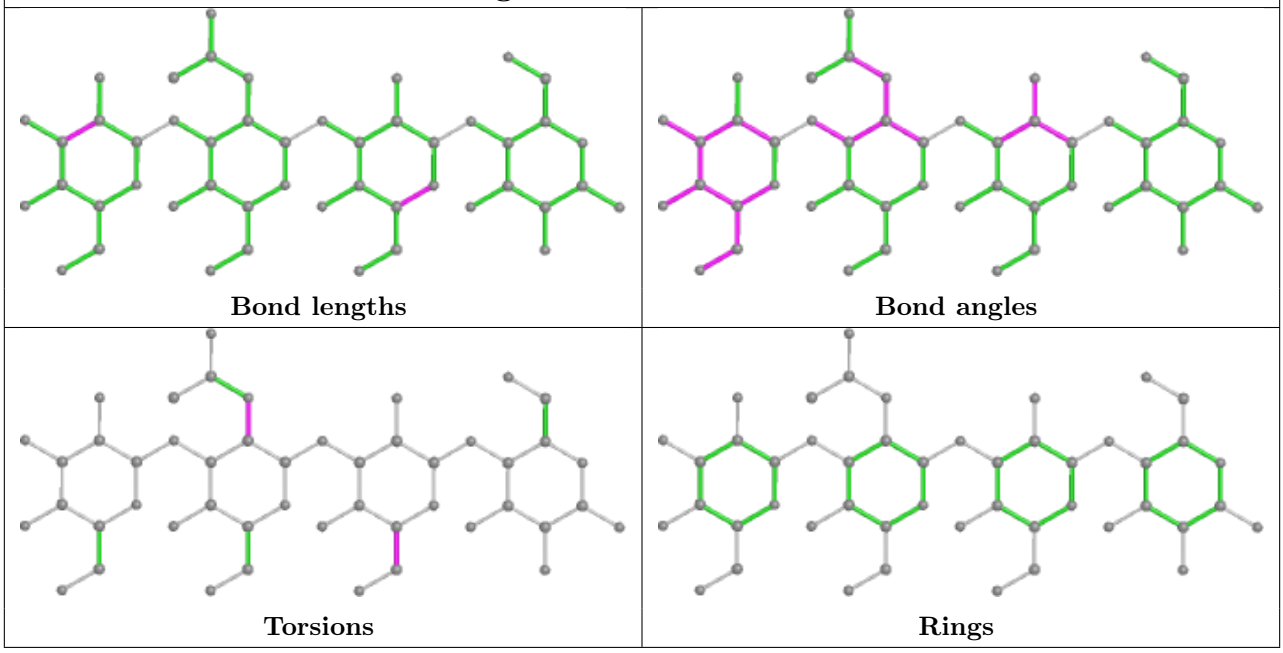
No monomer is involved in short contacts.

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

Oligosaccharide Chain C



Oligosaccharide Chain D



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	A	694/702 (98%)	-0.88	3 (0%)	92	91	18, 26, 46, 78	0
1	B	693/702 (98%)	-0.82	3 (0%)	92	91	19, 29, 49, 83	0
All	All	1387/1404 (98%)	-0.85	6 (0%)	92	91	18, 28, 48, 83	0

The worst 5 of 6 RSRZ outliers are listed below:

Mol	Chain	Res	Type	RSRZ
1	A	626	ASP	3.1
1	B	626	ASP	3.0
1	A	624	ALA	2.8
1	A	1	MET	2.6
1	B	675	SER	2.3

6.2 Non-standard residues in protein, DNA, RNA chains

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

6.3 Carbohydrates

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
2	GAL	C	4	11/12	0.91	0.15	27,31,41,43	0
2	NAG	D	3	14/15	0.91	0.12	29,39,44,46	0
2	BGC	D	1	12/12	0.92	0.09	39,50,59,65	0
2	GAL	D	2	11/12	0.92	0.11	40,56,65,70	0
2	GAL	C	2	11/12	0.92	0.11	35,49,61,67	0

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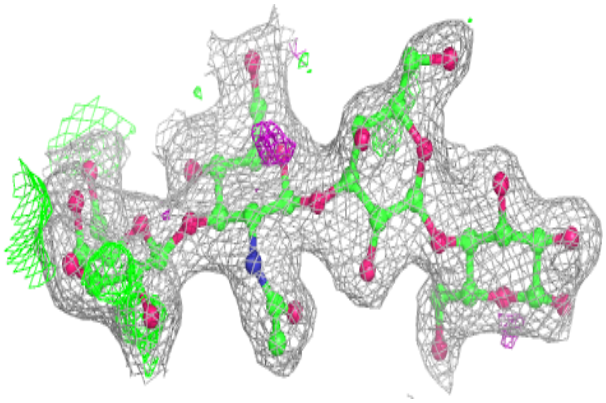
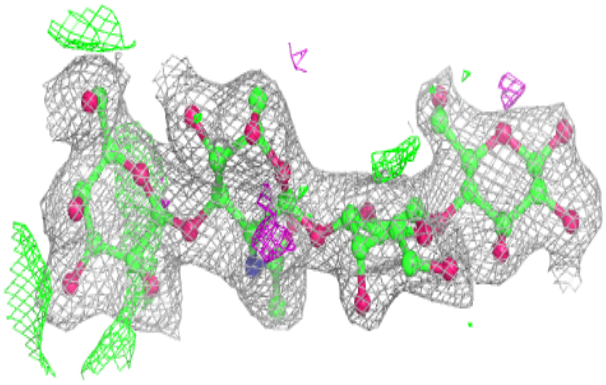
Mol	Type	Chain	Res	Atoms	RSCC	RSR	B-factors(Å^2)	Q<0.9
2	GAL	D	4	11/12	0.92	0.17	28,37,43,45	0
2	NAG	C	3	14/15	0.93	0.11	30,39,43,47	0
2	BGC	C	1	12/12	0.94	0.10	38,50,56,62	0

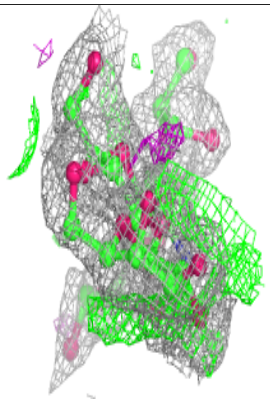
The following is a graphical depiction of the model fit to experimental electron density for oligosaccharide. Each fit is shown from different orientation to approximate a three-dimensional view.

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)

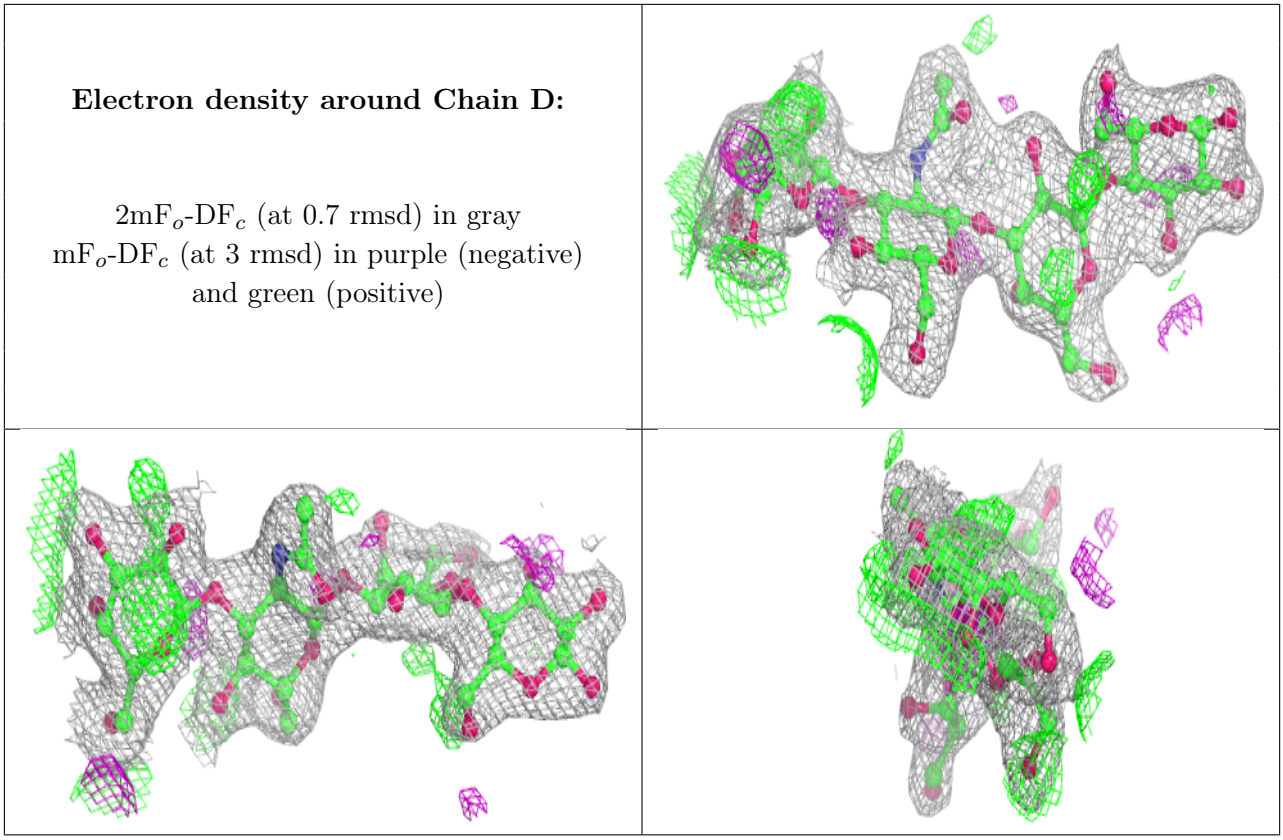






Electron density around Chain D:

$2mF_o$-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.