Full wwPDB X-ray Structure Validation Report (i)

Dec 3, 2023 – 06:41 am GMT

PDB ID	:	2WHL
Title	:	Understanding how diverse mannanases recognise heterogeneous substrates
Authors	:	Tailford, L.E.; Ducros, V.M.A.; Flint, J.E.; Roberts, S.M.; Morland, C.; Zechel, D.L.; Smith, N.; Bjornvad, M.E.; Borchert, T.V.; Wilson, K.S.; Davies, G.J.; Gilbert, H.J.
Deposited on	:	2009-05-05
Resolution	:	1.40 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:

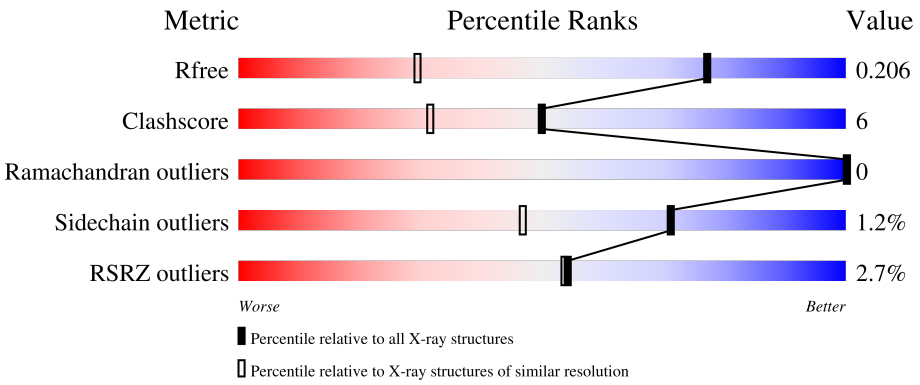
MolProbity	:	4.02b-467
Mogul	:	1.8.4, CSD as541be (2020)
Xtriage (Phenix)	:	1.13
EDS	:	2.36
Percentile statistics	:	20191225.v01 (using entries in the PDB archive December 25th 2019)
Refmac	:	5.8.0158
CCP4	:	7.0.044 (Gargrove)
Ideal geometry (proteins)	:	Engh & Huber (2001)
Ideal geometry (DNA, RNA)	:	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 1.40 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	1714 (1.40-1.40)
Clashscore	141614	1812 (1.40-1.40)
Ramachandran outliers	138981	1763 (1.40-1.40)
Sidechain outliers	138945	1762 (1.40-1.40)
RSRZ outliers	127900	1674 (1.40-1.40)

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	294	3% 89% 11%
2	B	3	100%

2 Entry composition (i)

There are 4 unique types of molecules in this entry. The entry contains 2682 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.

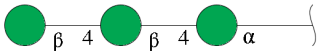
- Molecule 1 is a protein called BETA-MANNANASE.

Mol	Chain	Residues	Atoms					ZeroOcc	AltConf	Trace
			Total	C	N	O	S			
1	A	294	2370	1482	406	476	6	0	9	0

There are 12 discrepancies between the modelled and reference sequences:

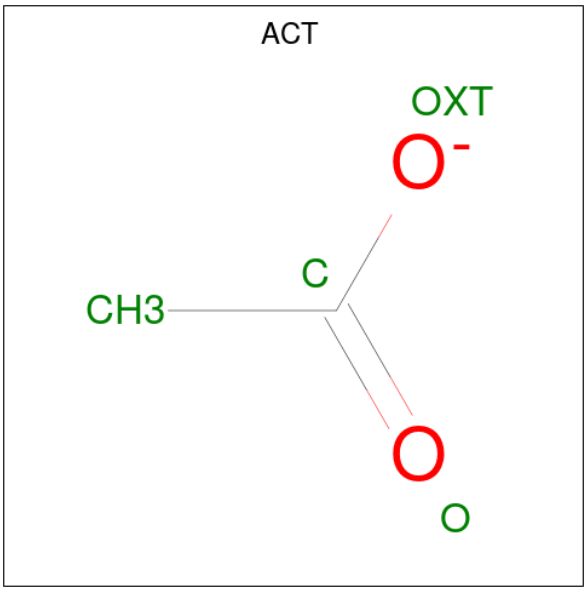
Chain	Residue	Modelled	Actual	Comment	Reference
A	6	SER	TYR	engineered mutation	UNP Q5YEX6
A	23	ARG	LYS	conflict	UNP Q5YEX6
A	69	ILE	VAL	conflict	UNP Q5YEX6
A	100	ASN	ASP	conflict	UNP Q5YEX6
A	135	SER	ALA	conflict	UNP Q5YEX6
A	188	MET	ILE	conflict	UNP Q5YEX6
A	?	-	GLY	deletion	UNP Q5YEX6
A	?	-	ASP	deletion	UNP Q5YEX6
A	258	THR	ALA	conflict	UNP Q5YEX6
A	259	SER	GLU	conflict	UNP Q5YEX6
A	272	GLN	ASN	conflict	UNP Q5YEX6
A	286	ASP	ASN	conflict	UNP Q5YEX6

- Molecule 2 is an oligosaccharide called beta-D-mannopyranose-(1-4)-beta-D-mannopyranose -(1-4)-alpha-D-mannopyranose.



Mol	Chain	Residues	Atoms			ZeroOcc	AltConf	Trace
			Total	C	O			
2	B	3	35	18	17	1	1	0

- Molecule 3 is ACETATE ION (three-letter code: ACT) (formula: $C_2H_3O_2$).



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

- Molecule 4 is water.

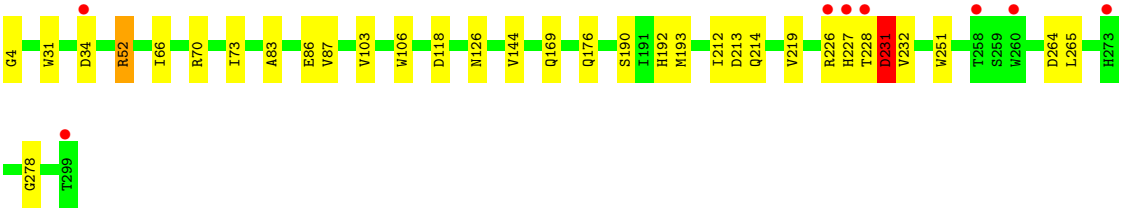
Mol	Chain	Residues	Atoms		ZeroOcc	AltConf
			Total	O		
4	A	273	273	273	0	0

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.

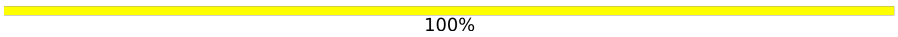
• Molecule 1: BETA-MANNANASE

Chain A:



• Molecule 2: beta-D-mannopyranose-(1-4)-beta-D-mannopyranose-(1-4)-alpha-D-mannopyranose

Chain B:



4 Data and refinement statistics (i)

Property	Value	Source
Space group	P 21 21 21	Depositor
Cell constants a, b, c, α, β, γ	58.26Å 63.69Å 83.58Å 90.00° 90.00° 90.00°	Depositor
Resolution (Å)	50.64 – 1.40 19.73 – 1.40	Depositor EDS
% Data completeness (in resolution range)	94.2 (50.64-1.40) 94.2 (19.73-1.40)	Depositor EDS
R_{merge}	0.05	Depositor
R_{sym}	(Not available)	Depositor
$< I/\sigma(I) >$ [1]	1.22 (at 1.40Å)	Xtriage
Refinement program	REFMAC 5.4.0062	Depositor
R, R_{free}	0.150 , 0.188 0.159 , 0.206	Depositor DCC
R_{free} test set	2980 reflections (5.07%)	wwPDB-VP
Wilson B-factor (Å^2)	16.4	Xtriage
Anisotropy	0.747	Xtriage
Bulk solvent k_{sol}(e/Å^3), B_{sol}(Å^2)	0.43 , 53.4	EDS
L-test for twinning[2]	$< \|L\| > = 0.49$, $< L^2 > = 0.32$	Xtriage
Estimated twinning fraction	No twinning to report.	Xtriage
F_o,F_c correlation	0.97	EDS
Total number of atoms	2682	wwPDB-VP
Average B, all atoms (Å^2)	21.0	wwPDB-VP

Xtriage's analysis on translational NCS is as follows: *The largest off-origin peak in the Patterson function is 6.59% 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: MAN, ACT, BMA

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	1.03	4/2445 (0.2%)	1.00	6/3330 (0.2%)

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	2	0

All (4) bond length outliers are listed below:

Mol	Chain	Res	Type	Atoms	Z	Observed(Å)	Ideal(Å)
1	A	83	ALA	CA-CB	6.13	1.65	1.52
1	A	251	TRP	CE3-CZ3	5.94	1.48	1.38
1	A	227	HIS	C-N	-5.80	1.20	1.34
1	A	193	MET	CG-SD	-5.31	1.67	1.81

All (6) bond angle outliers are listed below:

Mol	Chain	Res	Type	Atoms	Z	Observed(^{o})	Ideal(^{o})
1	A	83	ALA	N-CA-CB	6.50	119.20	110.10
1	A	34	ASP	CB-CG-OD1	6.30	123.97	118.30
1	A	52	ARG	NE-CZ-NH1	6.00	123.30	120.30
1	A	231	ASP	CB-CA-C	5.38	121.17	110.40
1	A	264	ASP	CB-CG-OD2	-5.11	113.70	118.30
1	A	212	ILE	CB-CA-C	5.04	121.67	111.60

All (2) chirality outliers are listed below:

Mol	Chain	Res	Type	Atom
1	A	231	ASP	CA
1	A	299	THR	CA

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	2370	0	2198	27	0
2	B	35	0	22	1	0
3	A	4	0	3	0	0
4	A	273	0	0	10	0
All	All	2682	0	2223	27	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 (27) 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:226:ARG:HG2	4:A:2211:HOH:O	1.36	1.23
1:A:226:ARG:HD3	1:A:232:VAL:H	1.21	1.04
1:A:52:ARG:HH22	1:A:126:ASN:HD22	1.11	0.97
1:A:118[A]:ASP:OD1	4:A:2136:HOH:O	1.93	0.86
1:A:70[B]:ARG:NH1	4:A:2078:HOH:O	2.10	0.83
1:A:226:ARG:HH11	1:A:231:ASP:N	1.78	0.81
1:A:226:ARG:NH1	1:A:231:ASP:N	2.29	0.80
1:A:226:ARG:HD3	1:A:232:VAL:N	1.97	0.80
1:A:73[A]:ILE:CG2	4:A:2140:HOH:O	2.38	0.71
1:A:226:ARG:HH11	1:A:231:ASP:CA	2.06	0.68
1:A:52:ARG:HH22	1:A:126:ASN:ND2	1.92	0.57
1:A:213:ASP:HB2	4:A:2199:HOH:O	2.06	0.56
1:A:73[A]:ILE:HG22	4:A:2140:HOH:O	2.06	0.54
1:A:103:VAL:HG21	1:A:144:VAL:HB	1.92	0.51
1:A:169[B]:GLN:NE2	4:A:2171:HOH:O	2.46	0.48
1:A:31:TRP:CD1	2:B:2:BMA:H3	2.51	0.45

Continued on next page...

Continued from previous page...

Atom-1	Atom-2	Interatomic distance (Å)	Clash overlap (Å)
1:A:169[B]:GLN:CG	4:A:2171:HOH:O	2.64	0.45
1:A:118[A]:ASP:CG	4:A:2136:HOH:O	2.52	0.43
1:A:265:LEU:O	1:A:278:GLY:HA3	2.19	0.43
1:A:126:ASN:HD21	1:A:192:HIS:HE1	1.67	0.42
1:A:87:VAL:HG23	1:A:106:TRP:CZ2	2.55	0.42
1:A:190:SER:HA	1:A:219:VAL:O	2.20	0.42
1:A:4:GLY:N	4:A:2002:HOH:O	2.53	0.41
1:A:66:ILE:O	1:A:70[B]:ARG:HG3	2.20	0.41
1:A:176[B]:GLN:OE1	1:A:214:GLN:NE2	2.53	0.41
1:A:226:ARG:HH11	1:A:231:ASP:HA	1.85	0.41
1:A:4:GLY:HA2	1:A:118[B]:ASP:OD1	2.20	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	A	299/294 (102%)	291 (97%)	8 (3%)	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	250/241 (104%)	247 (99%)	3 (1%)	71 47

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

Mol	Chain	Res	Type
1	A	86	GLU
1	A	228	THR
1	A	231	ASP

Sometimes sidechains can be flipped to improve hydrogen bonding and reduce clashes. All (3) such sidechains are listed below:

Mol	Chain	Res	Type
1	A	100	ASN
1	A	126	ASN
1	A	227	HIS

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	MAN	B	1[A]	-	12,12,12	0.74	0	17,17,17	3.03	6 (35%)
2	MAN	B	1[B]	-	12,12,12	4.52	1 (8%)	17,17,17	3.95	7 (41%)

Mol	Type	Chain	Res	Link	Bond lengths			Bond angles		
					Counts	RMSZ	$\#\|Z\| > 2$	Counts	RMSZ	$\#\|Z\| > 2$
2	BMA	B	2	2	11,11,12	0.73	0	15,15,17	0.89	0
2	BMA	B	3	2	11,11,12	0.76	0	15,15,17	1.34	1 (6%)

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	MAN	B	1[A]	-	-	1/2/22/22	0/1/1/1
2	MAN	B	1[B]	-	-	1/2/22/22	0/1/1/1
2	BMA	B	2	2	-	0/2/19/22	0/1/1/1
2	BMA	B	3	2	-	0/2/19/22	0/1/1/1

All (1) bond length outliers are listed below:

Mol	Chain	Res	Type	Atoms	Z	Observed(Å)	Ideal(Å)
2	B	1[B]	MAN	O1-C1	15.45	1.88	1.39

All (14) bond angle outliers are listed below:

Mol	Chain	Res	Type	Atoms	Z	Observed(^{o})	Ideal(^{o})
2	B	1[B]	MAN	O1-C1-O5	-8.14	85.95	110.38
2	B	1[B]	MAN	O1-C1-C2	-8.10	86.21	109.03
2	B	1[A]	MAN	O2-C2-C1	-7.15	92.57	109.16
2	B	1[B]	MAN	O2-C2-C1	-7.15	92.57	109.16
2	B	1[A]	MAN	O5-C1-C2	6.24	121.41	110.28
2	B	1[B]	MAN	O5-C1-C2	6.24	121.41	110.28
2	B	1[A]	MAN	O1-C1-C2	4.67	122.18	109.03
2	B	1[A]	MAN	C1-O5-C5	4.29	121.75	113.66
2	B	1[B]	MAN	C1-O5-C5	4.29	121.75	113.66
2	B	3	BMA	C1-C2-C3	3.15	113.54	109.67
2	B	1[A]	MAN	C1-C2-C3	3.04	116.61	110.31
2	B	1[B]	MAN	C1-C2-C3	3.04	116.61	110.31
2	B	1[A]	MAN	O4-C4-C5	-2.36	103.44	109.30
2	B	1[B]	MAN	O4-C4-C5	-2.36	103.44	109.30

There are no chirality outliers.

All (2) torsion outliers are listed below:

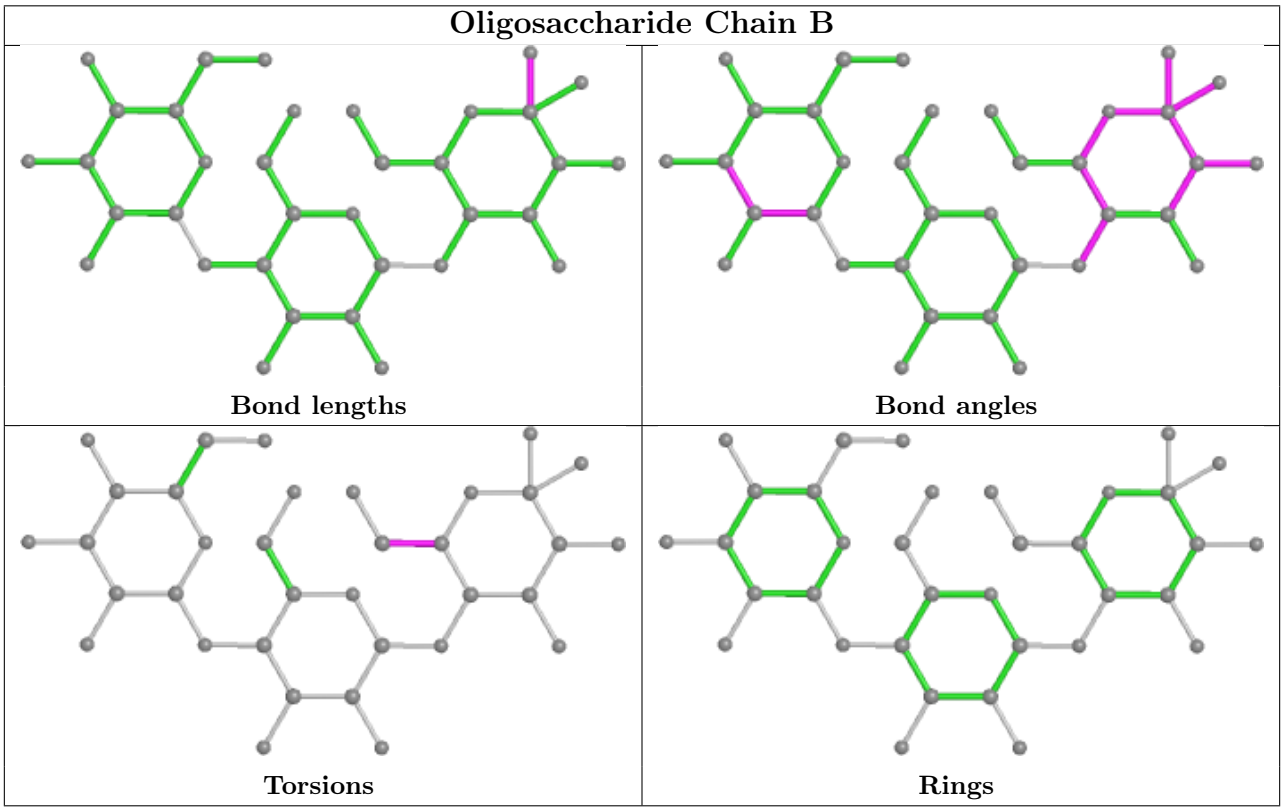
Mol	Chain	Res	Type	Atoms
2	B	1[A]	MAN	O5-C5-C6-O6
2	B	1[B]	MAN	O5-C5-C6-O6

There are no ring outliers.

1 monomer is involved in 1 short contact:

Mol	Chain	Res	Type	Clashes	Symm-Clashes
2	B	2	BMA	1	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.



5.6 Ligand geometry (i)

1 ligand is 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	ACT	A	1300	-	3,3,3	1.13	0	3,3,3	0.28	0

There are no bond length outliers.

There are no bond angle outliers.

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)

The following chains have linkage breaks:

Mol	Chain	Number of breaks
1	A	1

All chain breaks are listed below:

Model	Chain	Residue-1	Atom-1	Residue-2	Atom-2	Distance (Å)
1	A	228:THR	C	231:ASP	N	7.46

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	294/294 (100%)	-0.27	8 (2%) 54 54	13, 19, 29, 42	0

All (8) RSRZ outliers are listed below:

Mol	Chain	Res	Type	RSRZ
1	A	228	THR	6.2
1	A	227	HIS	4.7
1	A	299	THR	4.6
1	A	260	TRP	3.3
1	A	258	THR	2.6
1	A	34	ASP	2.3
1	A	226	ARG	2.3
1	A	273	HIS	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, 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	BMA	B	3	11/12	0.83	0.33	38,44,47,48	0
2	MAN	B	1[B]	12/12	0.92	0.08	22,27,32,34	1
2	MAN	B	1[A]	12/12	0.92	0.08	22,27,32,40	0
2	BMA	B	2	11/12	0.97	0.10	23,27,32,34	0

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	ACT	A	1300	4/4	0.88	0.14	33,34,34,36	0

6.5 Other polymers (i)

There are no such residues in this entry.