



Full wwPDB X-ray Structure Validation Report ⓘ

Dec 23, 2025 – 02:11 PM JST

PDB ID : 21KG / pdb_000021kg
Title : Faecalibacterium duncaniae branching enzyme FdBE2 maltohexaose complex
Authors : Tonozuka, T.; Ding, Y.; Sugimura, R.
Deposited on : 2025-12-16
Resolution : 1.60 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 : 20231227.v01 (using entries in the PDB archive December 27th 2023)
CCP4 : 9.0.011 (Gargrove)
Density-Fitness : 1.0.12
Ideal geometry (proteins) : Engh & Huber (2001)
Ideal geometry (DNA, RNA) : Parkinson et al. (1996)
Validation Pipeline (wwPDB-VP) : 2.47

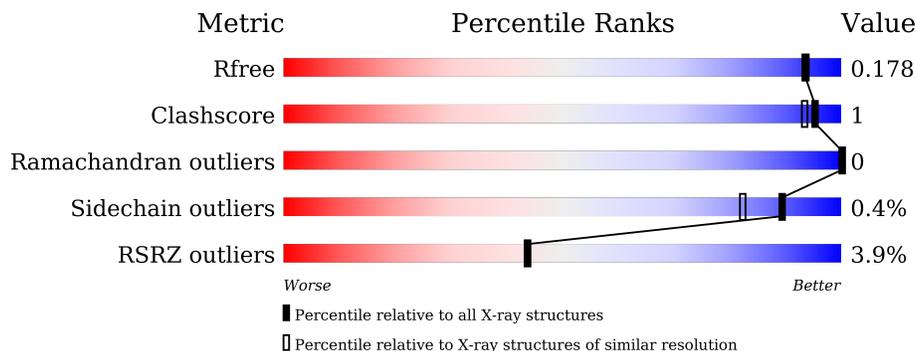
1 Overall quality at a glance

The following experimental techniques were used to determine the structure:

X-RAY DIFFRACTION

The reported resolution of this entry is 1.60 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}	164625	4274 (1.60-1.60)
Clashscore	180529	4682 (1.60-1.60)
Ramachandran outliers	177936	4583 (1.60-1.60)
Sidechain outliers	177891	4582 (1.60-1.60)
RSRZ outliers	164620	4272 (1.60-1.60)

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 $\leq 5\%$. 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	637	 4% 93% 5%
2	B	6	 67% 33%
2	C	6	 33% 67%

2 Entry composition [i](#)

There are 5 unique types of molecules in this entry. The entry contains 5638 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 1,4-alpha-glucan branching enzyme.

Mol	Chain	Residues	Atoms					ZeroOcc	AltConf	Trace
			Total	C	N	O	S			
1	A	608	4939	3163	842	903	31	0	0	0

There are 20 discrepancies between the modelled and reference sequences:

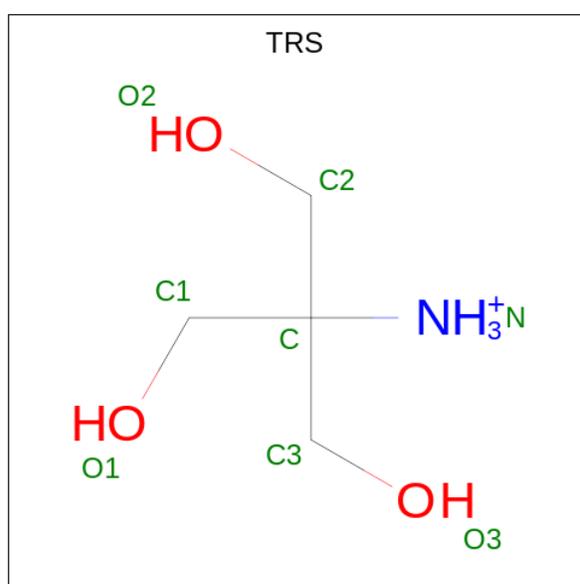
Chain	Residue	Modelled	Actual	Comment	Reference
A	-19	MET	-	initiating methionine	UNP C7H686
A	-18	GLY	-	expression tag	UNP C7H686
A	-17	SER	-	expression tag	UNP C7H686
A	-16	SER	-	expression tag	UNP C7H686
A	-15	HIS	-	expression tag	UNP C7H686
A	-14	HIS	-	expression tag	UNP C7H686
A	-13	HIS	-	expression tag	UNP C7H686
A	-12	HIS	-	expression tag	UNP C7H686
A	-11	HIS	-	expression tag	UNP C7H686
A	-10	HIS	-	expression tag	UNP C7H686
A	-9	SER	-	expression tag	UNP C7H686
A	-8	SER	-	expression tag	UNP C7H686
A	-7	GLY	-	expression tag	UNP C7H686
A	-6	LEU	-	expression tag	UNP C7H686
A	-5	VAL	-	expression tag	UNP C7H686
A	-4	PRO	-	expression tag	UNP C7H686
A	-3	ARG	-	expression tag	UNP C7H686
A	-2	GLY	-	expression tag	UNP C7H686
A	-1	SER	-	expression tag	UNP C7H686
A	0	HIS	-	expression tag	UNP C7H686

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



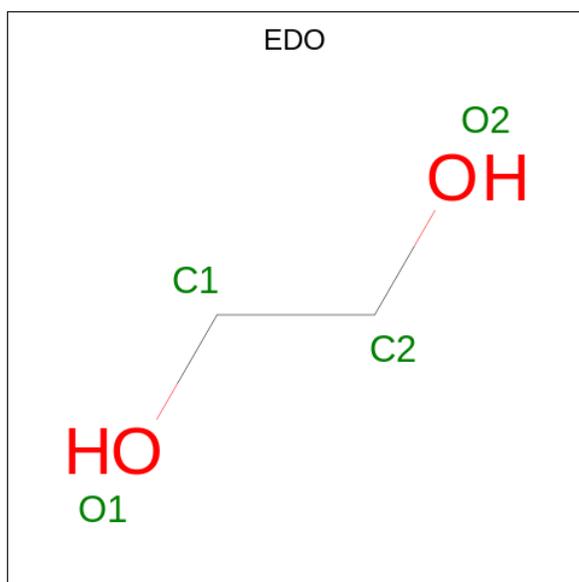
Mol	Chain	Residues	Atoms			ZeroOcc	AltConf	Trace
2	B	6	Total	C	O	0	0	0
			67	36	31			
2	C	6	Total	C	O	0	0	0
			67	36	31			

- Molecule 3 is 2-AMINO-2-HYDROXYMETHYL-PROPANE-1,3-DIOL (CCD ID: TRS) (formula: $C_4H_{12}NO_3$).



Mol	Chain	Residues	Atoms				ZeroOcc	AltConf
3	A	1	Total	C	N	O	0	0
			8	4	1	3		

- Molecule 4 is 1,2-ETHANEDIOL (CCD ID: EDO) (formula: $C_2H_6O_2$).



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

- Molecule 5 is water.

Mol	Chain	Residues	Atoms	ZeroOcc	AltConf
5	A	533	Total O 533 533	0	0

4 Data and refinement statistics i

Property	Value	Source
Space group	C 1 2 1	Depositor
Cell constants a, b, c, α , β , γ	165.40Å 73.48Å 56.97Å 90.00° 91.84° 90.00°	Depositor
Resolution (Å)	47.61 – 1.60 47.61 – 1.60	Depositor EDS
% Data completeness (in resolution range)	98.7 (47.61-1.60) 98.7 (47.61-1.60)	Depositor EDS
R_{merge}	0.02	Depositor
R_{sym}	(Not available)	Depositor
$\langle I/\sigma(I) \rangle$ ¹	2.84 (at 1.60Å)	Xtrriage
Refinement program	REFMAC 5.8.0267	Depositor
R, R_{free}	0.148 , 0.167 0.161 , 0.178	Depositor DCC
R_{free} test set	4359 reflections (4.85%)	wwPDB-VP
Wilson B-factor (Å ²)	18.0	Xtrriage
Anisotropy	0.047	Xtrriage
Bulk solvent k_{sol} (e/Å ³), B_{sol} (Å ²)	0.37 , 33.3	EDS
L-test for twinning ²	$\langle L \rangle = 0.49$, $\langle L^2 \rangle = 0.33$	Xtrriage
Estimated twinning fraction	0.019 for -h,-k,l	Xtrriage
F_o, F_c correlation	0.97	EDS
Total number of atoms	5638	wwPDB-VP
Average B, all atoms (Å ²)	23.0	wwPDB-VP

Xtrriage's analysis on translational NCS is as follows: *The largest off-origin peak in the Patterson function is 5.61% of the height of the origin peak. No significant pseudotranslation is detected.*

¹Intensities estimated from amplitudes.

²Theoretical 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: EDO, GLC, TRS

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	0.89	0/5104	1.09	0/6929

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	4939	0	4574	11	0
2	B	67	0	57	0	0
2	C	67	0	57	0	0
3	A	8	0	12	0	0
4	A	24	0	36	2	0
5	A	533	0	0	0	0
All	All	5638	0	4736	11	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 1.

All (11) 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:127:SER:OG	1:A:131:ARG:NH1	2.05	0.88
1:A:457:ASN:HD22	1:A:461:ASN:HD22	1.29	0.78
1:A:127:SER:HG	1:A:131:ARG:HH12	1.33	0.75
1:A:17:ASP:OD1	4:A:705:EDO:C2	2.52	0.57
1:A:424:LYS:HB3	1:A:428:ASP:HB3	1.91	0.52
1:A:533:LYS:HA	1:A:537:GLN:O	2.10	0.51
1:A:39:ALA:HA	1:A:71:TRP:O	2.18	0.44
1:A:9:SER:OG	4:A:705:EDO:H11	2.18	0.43
1:A:16:PHE:CZ	1:A:336:GLY:HA3	2.53	0.43
1:A:401:SER:HA	1:A:404:TYR:CE2	2.55	0.41
1:A:456:LEU:HD23	1:A:456:LEU:C	2.47	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	602/637 (94%)	589 (98%)	13 (2%)	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	501/526 (95%)	499 (100%)	2 (0%)	89 82

All (2) residues with a non-rotameric sidechain are listed below:

Mol	Chain	Res	Type
1	A	27	CYS
1	A	428	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	353	ASN
1	A	378	HIS
1	A	457	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](#)

12 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	GLC	B	1	2	12,12,12	0.44	0	17,17,17	0.61	0
2	GLC	B	2	2	11,11,12	0.39	0	15,15,17	1.04	1 (6%)
2	GLC	B	3	2	11,11,12	0.28	0	15,15,17	0.89	1 (6%)
2	GLC	B	4	2	11,11,12	0.31	0	15,15,17	0.81	0
2	GLC	B	5	2	11,11,12	0.29	0	15,15,17	0.79	0
2	GLC	B	6	2	11,11,12	0.35	0	15,15,17	0.85	0
2	GLC	C	1	2	12,12,12	0.61	0	17,17,17	1.28	2 (11%)

Mol	Type	Chain	Res	Link	Bond lengths			Bond angles		
					Counts	RMSZ	# Z > 2	Counts	RMSZ	# Z > 2
2	GLC	C	2	2	11,11,12	0.44	0	15,15,17	1.16	2 (13%)
2	GLC	C	3	2	11,11,12	0.54	0	15,15,17	0.99	0
2	GLC	C	4	2	11,11,12	0.39	0	15,15,17	0.93	1 (6%)
2	GLC	C	5	2	11,11,12	0.29	0	15,15,17	0.63	0
2	GLC	C	6	2	11,11,12	0.23	0	15,15,17	1.31	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	GLC	B	1	2	-	1/2/22/22	0/1/1/1
2	GLC	B	2	2	-	0/2/19/22	0/1/1/1
2	GLC	B	3	2	-	0/2/19/22	0/1/1/1
2	GLC	B	4	2	-	0/2/19/22	0/1/1/1
2	GLC	B	5	2	-	0/2/19/22	0/1/1/1
2	GLC	B	6	2	-	1/2/19/22	0/1/1/1
2	GLC	C	1	2	-	2/2/22/22	0/1/1/1
2	GLC	C	2	2	-	0/2/19/22	0/1/1/1
2	GLC	C	3	2	-	0/2/19/22	0/1/1/1
2	GLC	C	4	2	-	0/2/19/22	0/1/1/1
2	GLC	C	5	2	-	0/2/19/22	0/1/1/1
2	GLC	C	6	2	-	1/2/19/22	0/1/1/1

There are no bond length outliers.

All (8) bond angle outliers are listed below:

Mol	Chain	Res	Type	Atoms	Z	Observed(°)	Ideal(°)
2	C	6	GLC	C1-O5-C5	4.56	118.37	112.19
2	C	1	GLC	O5-C5-C4	3.36	115.79	109.69
2	B	2	GLC	C1-O5-C5	2.96	116.20	112.19
2	C	2	GLC	C1-O5-C5	2.93	116.16	112.19
2	C	1	GLC	C1-O5-C5	2.63	118.62	113.66
2	C	2	GLC	C1-C2-C3	2.47	112.70	109.67
2	B	3	GLC	C1-O5-C5	2.25	115.23	112.19
2	C	4	GLC	C1-O5-C5	2.06	114.99	112.19

There are no chirality outliers.

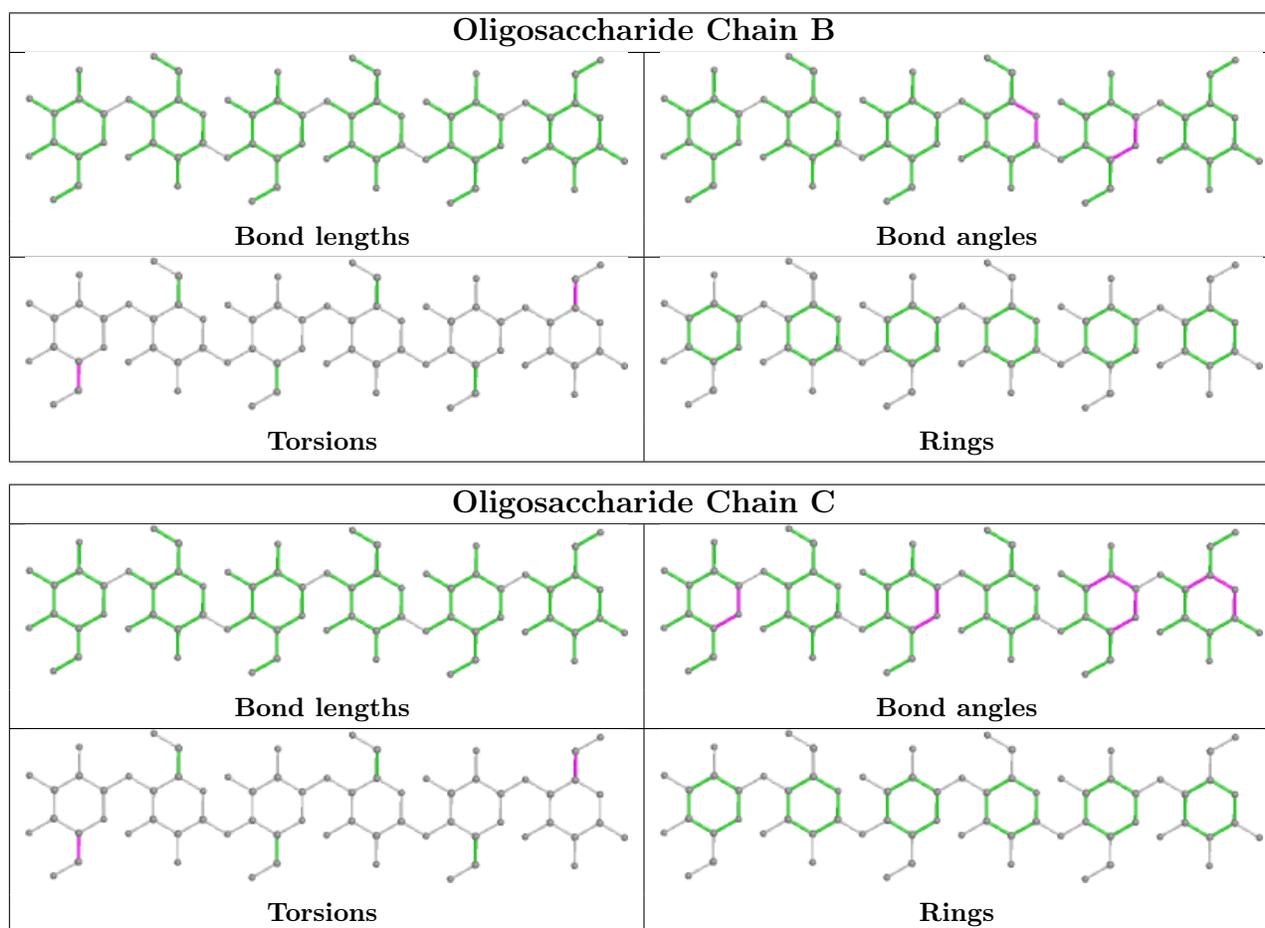
All (5) torsion outliers are listed below:

Mol	Chain	Res	Type	Atoms
2	C	1	GLC	C4-C5-C6-O6
2	C	1	GLC	O5-C5-C6-O6
2	B	6	GLC	C4-C5-C6-O6
2	C	6	GLC	C4-C5-C6-O6
2	B	1	GLC	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](#)

7 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	EDO	A	703	-	3,3,3	0.05	0	2,2,2	0.13	0
4	EDO	A	706	-	3,3,3	0.06	0	2,2,2	0.18	0
4	EDO	A	707	-	3,3,3	0.10	0	2,2,2	0.45	0
4	EDO	A	705	-	3,3,3	0.05	0	2,2,2	0.36	0
4	EDO	A	702	-	3,3,3	0.14	0	2,2,2	0.22	0
4	EDO	A	704	-	3,3,3	0.07	0	2,2,2	0.51	0
3	TRS	A	701	-	7,7,7	0.13	0	9,9,9	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
4	EDO	A	703	-	-	0/1/1/1	-
4	EDO	A	706	-	-	1/1/1/1	-
4	EDO	A	707	-	-	1/1/1/1	-
4	EDO	A	705	-	-	0/1/1/1	-
4	EDO	A	702	-	-	0/1/1/1	-
4	EDO	A	704	-	-	1/1/1/1	-
3	TRS	A	701	-	-	0/9/9/9	-

There are no bond length outliers.

There are no bond angle outliers.

There are no chirality outliers.

All (3) torsion outliers are listed below:

Mol	Chain	Res	Type	Atoms
4	A	707	EDO	O1-C1-C2-O2
4	A	704	EDO	O1-C1-C2-O2
4	A	706	EDO	O1-C1-C2-O2

There are no ring outliers.

1 monomer is involved in 2 short contacts:

Mol	Chain	Res	Type	Clashes	Symm-Clashes
4	A	705	EDO	2	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

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, 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	608/637 (95%)	-0.04	24 (3%) 44 44	13, 19, 36, 86	0

All (24) RSRZ outliers are listed below:

Mol	Chain	Res	Type	RSRZ
1	A	271	TRP	6.6
1	A	156	ALA	6.1
1	A	162	SER	4.7
1	A	617	ALA	4.4
1	A	163	ASP	4.1
1	A	161	GLY	4.0
1	A	269	SER	3.7
1	A	263	ASP	3.4
1	A	120	ASP	3.4
1	A	155	ASN	3.4
1	A	31	PHE	3.3
1	A	264	SER	3.1
1	A	27	CYS	3.0
1	A	593	TYR	2.9
1	A	164	GLY	2.8
1	A	270	GLU	2.8
1	A	577	ALA	2.6
1	A	3	PHE	2.5
1	A	262	TYR	2.3
1	A	272	GLY	2.1
1	A	118	ARG	2.1
1	A	421	HIS	2.1
1	A	403	GLN	2.0
1	A	30	ASP	2.0

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](#)

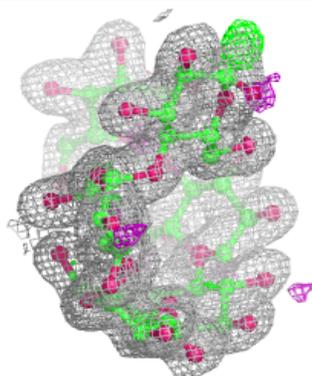
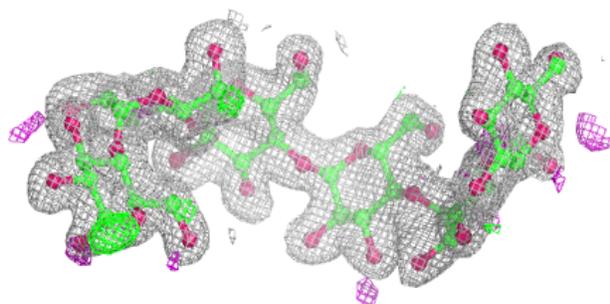
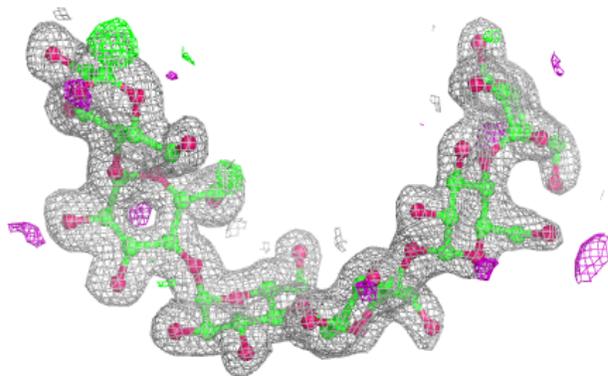
In the following table, the Atoms column lists the number of modelled atoms in the group and the number defined in the chemical component dictionary. The B-factors column lists the minimum, median, 95th percentile and maximum values of B factors of atoms in the group. The column labelled 'Q< 0.9' lists 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	GLC	C	6	11/12	0.63	0.15	53,58,62,62	0
2	GLC	C	1	12/12	0.81	0.13	34,38,40,44	0
2	GLC	B	4	11/12	0.86	0.11	36,37,39,40	0
2	GLC	C	5	11/12	0.87	0.11	34,38,41,47	0
2	GLC	B	5	11/12	0.87	0.12	35,39,41,43	0
2	GLC	B	1	12/12	0.89	0.10	26,28,31,34	0
2	GLC	B	6	11/12	0.90	0.11	30,33,36,40	0
2	GLC	B	3	11/12	0.90	0.09	29,31,35,36	0
2	GLC	C	3	11/12	0.91	0.09	29,31,35,38	0
2	GLC	B	2	11/12	0.91	0.09	24,26,29,30	0
2	GLC	C	2	11/12	0.91	0.09	31,33,35,38	0
2	GLC	C	4	11/12	0.94	0.07	23,28,32,33	0

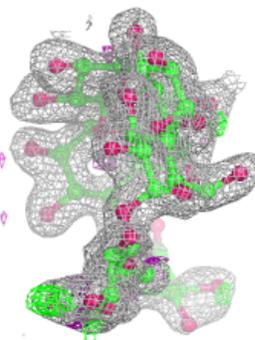
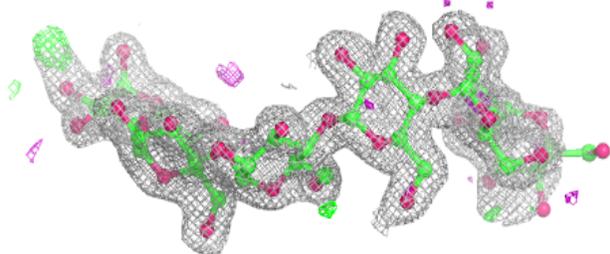
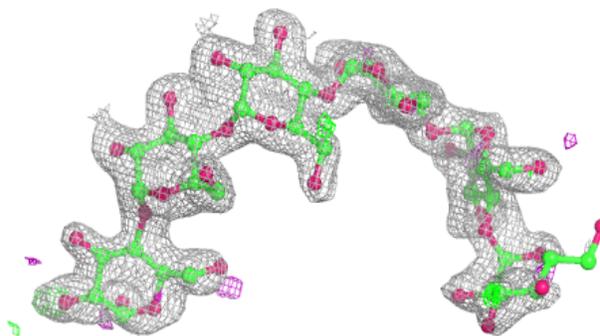
The following is a graphical depiction of the model fit to experimental electron density for oligosaccharide. Each fit is shown from different orientation to approximate a three-dimensional view.

Electron density around Chain B:

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

**Electron density around Chain C:**

$2mF_o-DF_c$ (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(\AA^2)	Q<0.9
4	EDO	A	705	4/4	0.85	0.14	38,39,40,41	0
4	EDO	A	706	4/4	0.85	0.15	31,32,35,37	0
4	EDO	A	707	4/4	0.85	0.17	33,33,33,34	0
4	EDO	A	703	4/4	0.93	0.10	35,36,36,38	0
4	EDO	A	702	4/4	0.94	0.08	20,21,22,24	0
3	TRS	A	701	8/8	0.94	0.08	22,23,23,23	0
4	EDO	A	704	4/4	0.94	0.10	32,33,34,36	0

6.5 Other polymers [i](#)

There are no such residues in this entry.