



# wwPDB X-ray Structure Validation Summary Report ⓘ

Aug 21, 2020 – 04:05 PM BST

PDB ID : 4AD2  
Title : Structure of the GH99 endo-alpha-mannosidase from *Bacteroides xylophilus* in complex with glucose-1,3-isofagomine  
Authors : Thompson, A.J.; Williams, R.J.; Hakki, Z.; Alonzi, D.S.; Wennekes, T.; Gloster, T.M.; Songsrirote, K.; Thomas-Oates, J.E.; Wrodnigg, T.M.; Spreitz, J.; Stuetz, A.E.; Butters, T.D.; Williams, S.J.; Davies, G.J.  
Deposited on : 2011-12-21  
Resolution : 2.10 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](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 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)  
Xtriage (Phenix) : 1.13  
EDS : 2.13.1  
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) : 2.13.1

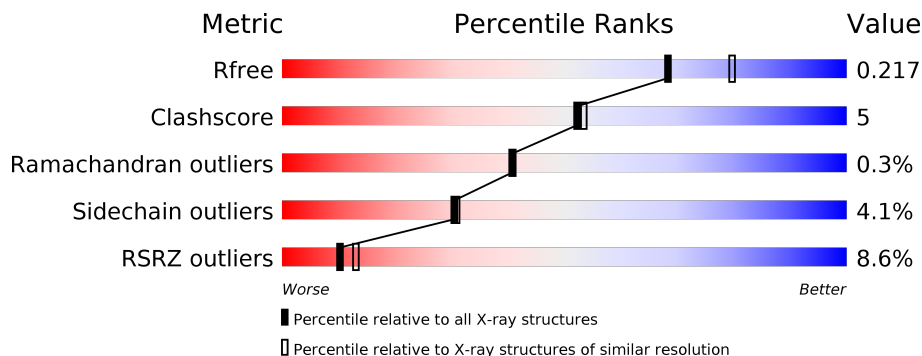
# 1 Overall quality at a glance

The following experimental techniques were used to determine the structure:

*X-RAY DIFFRACTION*

The reported resolution of this entry is 2.10 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	5197 (2.10-2.10)
Clashscore	141614	5710 (2.10-2.10)
Ramachandran outliers	138981	5647 (2.10-2.10)
Sidechain outliers	138945	5648 (2.10-2.10)
RSRZ outliers	127900	5083 (2.10-2.10)

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 on 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	380	 2% 84% 6% • 9%
1	B	380	 84% 6% • 9%
1	C	380	 80% 8% • 9%
1	D	380	 29% 69% 19% • 10%

## 2 Entry composition [i](#)

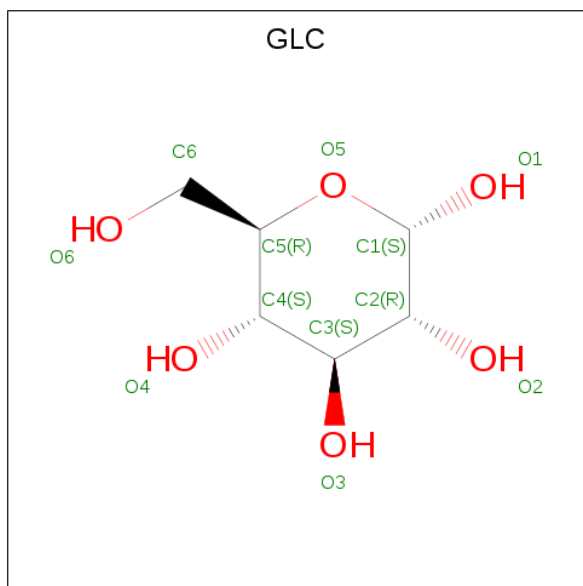
There are 4 unique types of molecules in this entry. The entry contains 12467 atoms, of which 0 are hydrogens and 0 are deuteriums.

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 GLYCOSYL HYDROLASE FAMILY 71.

Mol	Chain	Residues	Atoms					ZeroOcc	AltConf	Trace
			Total	C	N	O	S			
1	A	345	Total 2826	C 1822	N 468	O 528	S 8	0	5	0
1	B	346	Total 2832	C 1827	N 470	O 526	S 9	0	4	0
1	C	344	Total 2806	C 1808	N 467	O 523	S 8	0	1	0
1	D	342	Total 2545	C 1628	N 432	O 478	S 7	0	0	0

- Molecule 2 is alpha-D-glucopyranose (three-letter code: GLC) (formula: C<sub>6</sub>H<sub>12</sub>O<sub>6</sub>).



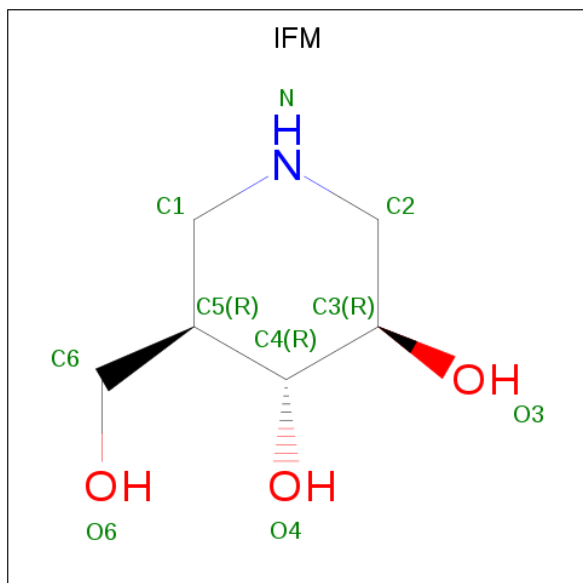
Mol	Chain	Residues	Atoms			ZeroOcc	AltConf
			Total	C	O		
2	A	1	Total 11	C 6	O 5	0	0
2	B	1	Total 11	C 6	O 5	0	0

*Continued on next page...*

Continued from previous page...

Mol	Chain	Residues	Atoms			ZeroOcc	AltConf
2	C	1	Total	C	O	0	0
			11	6	5		
2	D	1	Total	C	O	0	0
			11	6	5		

- Molecule 3 is 5-HYDROXYMETHYL-3,4-DIHYDROXYPIPERIDINE (three-letter code: IFM) (formula:  $C_6H_{13}NO_3$ ).



Mol	Chain	Residues	Atoms				ZeroOcc	AltConf
3	A	1	Total	C	N	O	0	0
			10	6	1	3		
3	B	1	Total	C	N	O	0	0
			10	6	1	3		
3	C	1	Total	C	N	O	0	0
			10	6	1	3		
3	D	1	Total	C	N	O	0	0
			10	6	1	3		

- Molecule 4 is water.

Mol	Chain	Residues	Atoms		ZeroOcc	AltConf
4	A	416	Total	O	0	0
			416	416		
4	B	444	Total	O	0	0
			444	444		
4	C	387	Total	O	0	0
			387	387		

Continued on next page...

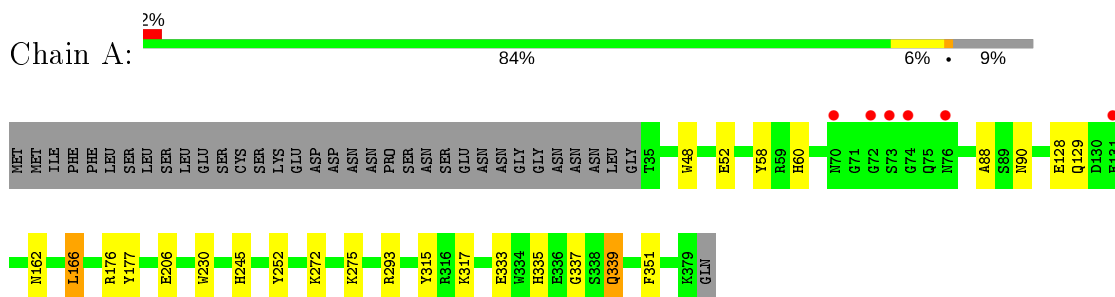
*Continued from previous page...*

<b>Mol</b>	<b>Chain</b>	<b>Residues</b>	<b>Atoms</b>		<b>ZeroOcc</b>	<b>AltConf</b>
4	D	127	Total	O	0	0
			127	127		

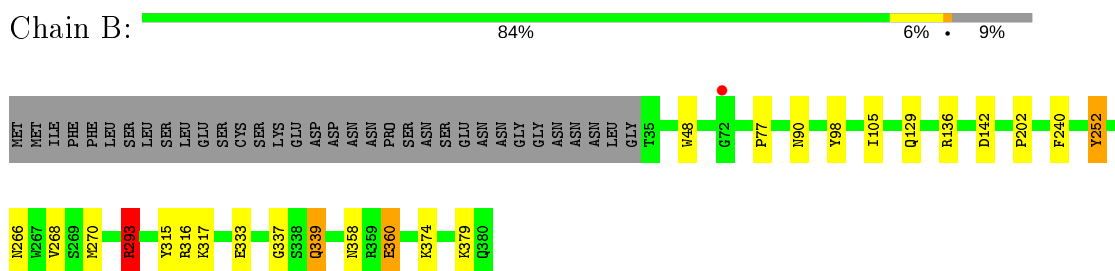
### 3 Residue-property plots [i](#)

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.

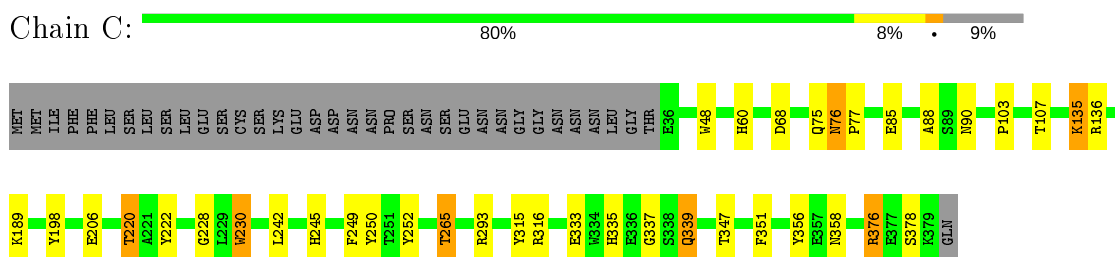
- Molecule 1: GLYCOSYL HYDROLASE FAMILY 71



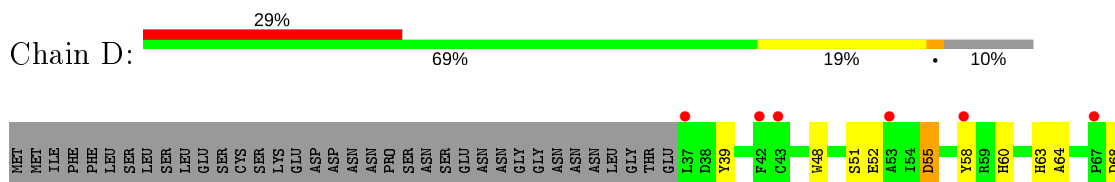
- Molecule 1: GLYCOSYL HYDROLASE FAMILY 71

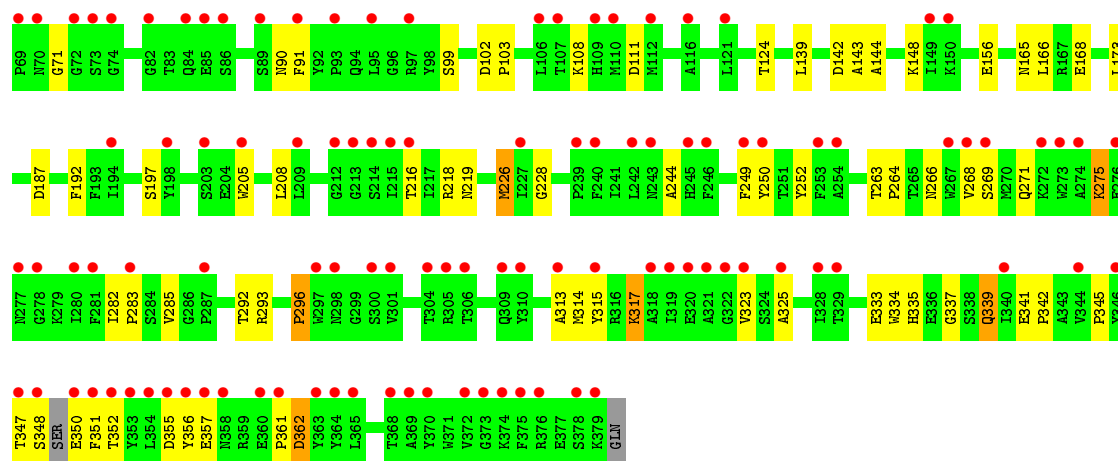


- Molecule 1: GLYCOSYL HYDROLASE FAMILY 71



- Molecule 1: GLYCOSYL HYDROLASE FAMILY 71





## 4 Data and refinement statistics

Property	Value	Source
Space group	P 31 2 1	Depositor
Cell constants a, b, c, $\alpha$ , $\beta$ , $\gamma$	223.30 Å 223.30 Å 84.77 Å 90.00° 90.00° 120.00°	Depositor
Resolution (Å)	44.36 – 2.10 44.36 – 2.10	Depositor EDS
% Data completeness (in resolution range)	100.0 (44.36-2.10) 99.9 (44.36-2.10)	Depositor EDS
$R_{merge}$	0.18	Depositor
$R_{sym}$	(Not available)	Depositor
$\langle I/\sigma(I) \rangle$ <sup>1</sup>	3.29 (at 2.10 Å)	Xtriage
Refinement program	REFMAC 5.6.0086	Depositor
R, $R_{free}$	0.186 , 0.217 0.186 , 0.217	Depositor DCC
$R_{free}$ test set	7043 reflections (5.00%)	wwPDB-VP
Wilson B-factor (Å <sup>2</sup> )	23.6	Xtriage
Anisotropy	0.042	Xtriage
Bulk solvent $k_{sol}$ (e/Å <sup>3</sup> ), $B_{sol}$ (Å <sup>2</sup> )	0.30 , 55.8	EDS
L-test for twinning <sup>2</sup>	$\langle  L  \rangle = 0.48$ , $\langle L^2 \rangle = 0.31$	Xtriage
Estimated twinning fraction	0.026 for -h,-k,l	Xtriage
$F_o, F_c$ correlation	0.94	EDS
Total number of atoms	12467	wwPDB-VP
Average B, all atoms (Å <sup>2</sup> )	29.0	wwPDB-VP

Xtriage's analysis on translational NCS is as follows: *The largest off-origin peak in the Patterson function is 2.15% 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: IFM, GLC

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	0.75	0/2933	0.68	0/3995
1	B	0.67	0/2936	0.68	4/3999 (0.1%)
1	C	0.74	1/2901 (0.0%)	0.68	2/3950 (0.1%)
1	D	0.59	0/2627	0.63	1/3602 (0.0%)
All	All	0.69	1/11397 (0.0%)	0.67	7/15546 (0.0%)

All (1) bond length outliers are listed below:

Mol	Chain	Res	Type	Atoms	Z	Observed(Å)	Ideal(Å)
1	C	356	TYR	CD1-CE1	-5.94	1.30	1.39

The worst 5 of 7 bond angle outliers are listed below:

Mol	Chain	Res	Type	Atoms	Z	Observed(°)	Ideal(°)
1	B	136	ARG	NE-CZ-NH2	-7.70	116.45	120.30
1	B	293	ARG	NE-CZ-NH2	-6.50	117.05	120.30
1	B	136	ARG	NE-CZ-NH1	5.98	123.29	120.30
1	D	296	PRO	N-CA-CB	5.58	109.99	103.30
1	C	376	ARG	NE-CZ-NH2	-5.24	117.68	120.30

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	2826	0	2681	17	0
1	B	2832	0	2691	16	0
1	C	2806	0	2662	36	0
1	D	2545	0	2183	52	1
2	A	11	0	10	1	0
2	B	11	0	10	0	0
2	C	11	0	10	0	0
2	D	11	0	10	0	0
3	A	10	0	12	1	0
3	B	10	0	12	2	0
3	C	10	0	12	1	0
3	D	10	0	12	0	0
4	A	416	0	0	4	1
4	B	444	0	0	3	0
4	C	387	0	0	12	0
4	D	127	0	0	9	0
All	All	12467	0	10305	117	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 5.

The worst 5 of 117 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:C:85:GLU:HG2	4:C:2355:HOH:O	1.53	1.06
1:B:316:ARG:HH21	1:C:358:ASN:ND2	1.55	1.04
1:C:347:THR:HG22	4:C:2350:HOH:O	1.63	0.98
1:B:316:ARG:HH21	1:C:358:ASN:HD21	0.98	0.97
1:B:316:ARG:NH2	1:C:358:ASN:HD21	1.63	0.95

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:2185:HOH:O	4:A:2185:HOH:O[6_555]	0.77	1.43
1:D:187:ASP:O	1:D:219:ASN:ND2[6_554]	1.98	0.22

## 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	348/380 (92%)	338 (97%)	9 (3%)	1 (0%)	41	41
1	B	348/380 (92%)	338 (97%)	9 (3%)	1 (0%)	41	41
1	C	343/380 (90%)	333 (97%)	10 (3%)	0	100	100
1	D	338/380 (89%)	316 (94%)	20 (6%)	2 (1%)	25	21
All	All	1377/1520 (91%)	1325 (96%)	48 (4%)	4 (0%)	41	41

All (4) Ramachandran outliers are listed below:

Mol	Chain	Res	Type
1	A	252	TYR
1	D	252	TYR
1	B	252	TYR
1	D	361	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	298/328 (91%)	290 (97%)	8 (3%)	44	48
1	B	298/328 (91%)	288 (97%)	10 (3%)	37	39
1	C	295/328 (90%)	282 (96%)	13 (4%)	28	28
1	D	228/328 (70%)	213 (93%)	15 (7%)	16	14
All	All	1119/1312 (85%)	1073 (96%)	46 (4%)	30	31

5 of 46 residues with a non-rotameric sidechain are listed below:

Mol	Chain	Res	Type
1	C	77	PRO
1	C	242	LEU
1	D	317	LYS
1	C	135	LYS
1	C	220	THR

Some sidechains can be flipped to improve hydrogen bonding and reduce clashes. 5 of 27 such sidechains are listed below:

Mol	Chain	Res	Type
1	B	380	GLN
1	C	90	ASN
1	D	271	GLN
1	C	60	HIS
1	A	245	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](#)

There are no monosaccharides in this entry.

## 5.6 Ligand geometry [i](#)

8 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	IFM	A	501	2	9,10,10	0.99	0	9,13,13	1.69	1 (11%)
3	IFM	C	501	2	9,10,10	1.18	1 (11%)	9,13,13	1.87	2 (22%)
3	IFM	D	501	2	9,10,10	0.88	1 (11%)	9,13,13	2.55	1 (11%)
2	GLC	B	500	3	11,11,12	0.53	0	15,15,17	1.20	2 (13%)
3	IFM	B	501	2	9,10,10	0.83	1 (11%)	9,13,13	1.41	1 (11%)
2	GLC	D	500	3	11,11,12	0.68	0	15,15,17	0.84	0
2	GLC	C	500	3	11,11,12	0.56	0	15,15,17	1.06	2 (13%)
2	GLC	A	500	3	11,11,12	0.61	0	15,15,17	1.26	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
3	IFM	A	501	2	-	0/2/16/16	0/1/1/1
3	IFM	C	501	2	-	0/2/16/16	0/1/1/1
3	IFM	D	501	2	-	0/2/16/16	0/1/1/1
2	GLC	B	500	3	-	0/2/19/22	0/1/1/1
3	IFM	B	501	2	-	0/2/16/16	0/1/1/1
2	GLC	D	500	3	-	2/2/19/22	0/1/1/1
2	GLC	C	500	3	-	0/2/19/22	0/1/1/1
2	GLC	A	500	3	-	0/2/19/22	0/1/1/1

All (3) bond length outliers are listed below:

Mol	Chain	Res	Type	Atoms	Z	Observed(Å)	Ideal(Å)
3	C	501	IFM	C2-C3	3.20	1.55	1.52
3	D	501	IFM	C2-C3	2.18	1.54	1.52
3	B	501	IFM	C2-C3	2.14	1.54	1.52

The worst 5 of 10 bond angle outliers are listed below:

Mol	Chain	Res	Type	Atoms	Z	Observed(°)	Ideal(°)
3	D	501	IFM	C1-N-C2	7.00	119.39	111.70
3	C	501	IFM	C1-N-C2	4.86	117.03	111.70
2	A	500	GLC	C1-O5-C5	3.99	117.60	112.19
3	A	501	IFM	C1-N-C2	3.96	116.05	111.70
3	B	501	IFM	C1-N-C2	3.58	115.63	111.70

There are no chirality outliers.

All (2) torsion outliers are listed below:

Mol	Chain	Res	Type	Atoms
2	D	500	GLC	O5-C5-C6-O6
2	D	500	GLC	C4-C5-C6-O6

There are no ring outliers.

4 monomers are involved in 4 short contacts:

Mol	Chain	Res	Type	Clashes	Symm-Clashes
3	A	501	IFM	1	0
3	C	501	IFM	1	0
3	B	501	IFM	2	0
2	A	500	GLC	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, 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	345/380 (90%)	-0.59	6 (1%) 70 74	13, 19, 32, 67	0
1	B	346/380 (91%)	-0.52	1 (0%) 94 94	12, 19, 32, 49	0
1	C	344/380 (90%)	-0.63	0 100 100	12, 19, 31, 51	0
1	D	342/380 (90%)	1.58	112 (32%) 0 0	30, 56, 77, 85	0
All	All	1377/1520 (90%)	-0.04	119 (8%) 10 13	12, 22, 64, 85	0

The worst 5 of 119 RSRZ outliers are listed below:

Mol	Chain	Res	Type	RSRZ
1	D	363	TYR	11.4
1	D	347	THR	6.3
1	D	353	TYR	6.2
1	D	378	SER	6.1
1	D	352	THR	5.5

### 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](#)

There are no monosaccharides in this entry.

### 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( $\text{\AA}^2$ )	Q<0.9
3	IFM	D	501	10/10	0.77	0.21	39,44,45,45	0
2	GLC	D	500	11/12	0.94	0.15	41,42,43,45	0
3	IFM	A	501	10/10	0.97	0.08	14,14,14,15	0
3	IFM	C	501	10/10	0.97	0.11	14,15,15,16	0
3	IFM	B	501	10/10	0.98	0.16	14,14,15,16	0
2	GLC	B	500	11/12	0.98	0.12	16,17,19,20	0
2	GLC	C	500	11/12	0.98	0.08	18,19,21,22	0
2	GLC	A	500	11/12	0.98	0.05	17,17,19,19	0

## 6.5 Other polymers [i](#)

There are no such residues in this entry.