



# wwPDB X-ray Structure Validation Summary Report ⓘ

May 4, 2016 – 08:06 PM EDT

PDB ID : 5E70  
Title : Crystal structure of Ecoli Branching Enzyme with gamma cyclodextrin  
Authors : Feng, L.; Nosrati, M.; Geiger, J.H.  
Deposited on : 2015-10-11  
Resolution : 2.33 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  
<http://wwpdb.org/validation/2016/XrayValidationReportHelp>  
with specific help available everywhere you see the ⓘ symbol.

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The following versions of software and data (see [references ⓘ](#)) were used in the production of this report:

MolProbity : 4.02b-467  
Mogul : 1.7.1 (RC1), CSD as537be (2016)  
Xtriage (Phenix) : 1.9-1692  
EDS : rb-20027457  
Percentile statistics : 20151230.v01 (using entries in the PDB archive December 30th 2015)  
Refmac : 5.8.0135  
CCP4 : 6.5.0  
Ideal geometry (proteins) : Engh & Huber (2001)  
Ideal geometry (DNA, RNA) : Parkinson et al. (1996)  
Validation Pipeline (wwPDB-VP) : rb-20027457

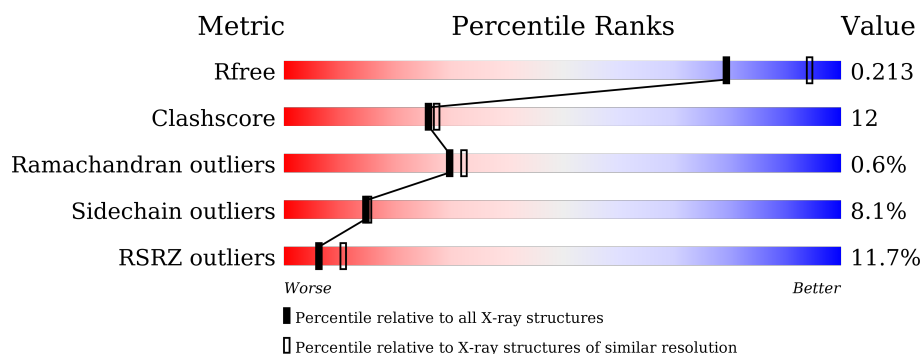
# 1 Overall quality at a glance

The following experimental techniques were used to determine the structure:

*X-RAY DIFFRACTION*

The reported resolution of this entry is 2.33 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))
$R_{free}$	91344	1406 (2.36-2.32)
Clashscore	102246	1509 (2.36-2.32)
Ramachandran outliers	100387	1490 (2.36-2.32)
Sidechain outliers	100360	1491 (2.36-2.32)
RSRZ outliers	91569	1412 (2.36-2.32)

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. 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	612	<div> <div>11%</div> <div> <div></div> <div>72%</div> <div>20%</div> <div>• •</div> </div> </div>
1	B	612	<div> <div>%</div> <div> <div></div> <div>77%</div> <div>17%</div> <div>• •</div> </div> </div>
1	C	612	<div> <div>32%</div> <div> <div></div> <div>70%</div> <div>21%</div> <div>• 6%</div> </div> </div>
1	D	612	<div> <div>2%</div> <div> <div></div> <div>73%</div> <div>19%</div> <div>• •</div> </div> </div>

The following table lists non-polymeric compounds, carbohydrate monomers and non-standard residues in protein, DNA, RNA chains that are outliers for geometric or electron-density-fit crite-

ria:

Mol	Type	Chain	Res	Chirality	Geometry	Clashes	Electron density
2	RCD	B	801	-	-	-	X
2	RCD	C	801	-	-	-	X
2	RCD	D	801	-	-	-	X
3	GOL	A	802	-	-	-	X
3	GOL	A	803	-	-	-	X
3	GOL	B	803	-	-	-	X

2 Entry composition ⓘ

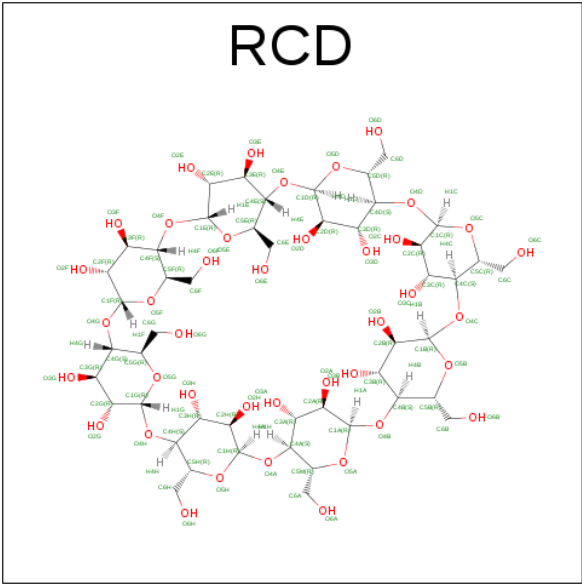
There are 4 unique types of molecules in this entry. The entry contains 21132 atoms, of which 0 are hydrogens and 0 are deuteriums.

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 GlgB.

Mol	Chain	Residues	Atoms					ZeroOcc	AltConf	Trace
1	A	586	Total	C	N	O	S	0	6	0
			4871	3110	868	877	16			
1	B	600	Total	C	N	O	S	0	2	0
			4960	3170	880	894	16			
1	C	578	Total	C	N	O	S	0	2	0
			4768	3052	845	855	16			
1	D	588	Total	C	N	O	S	0	2	0
			4852	3103	862	871	16			

- Molecule 2 is gamma-cyclodextrin (three-letter code: RCD) (formula: C<sub>48</sub>H<sub>80</sub>O<sub>40</sub>).



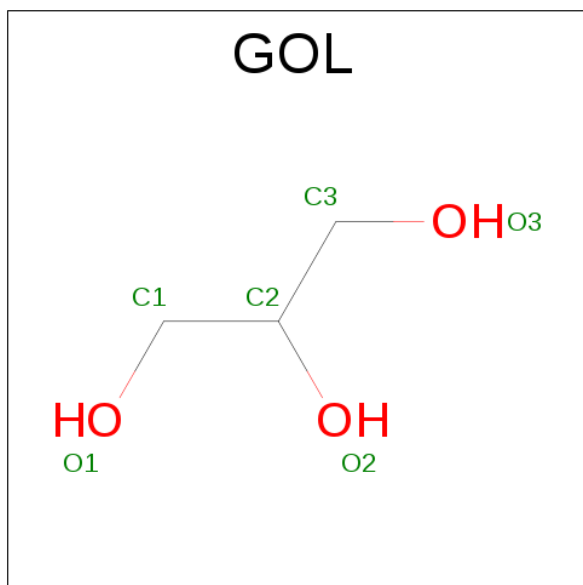
Mol	Chain	Residues	Atoms			ZeroOcc	AltConf
2	A	1	Total	C	O	0	0
			88	48	40		
2	B	1	Total	C	O	0	0
			88	48	40		

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Mol	Chain	Residues	Atoms			ZeroOcc	AltConf
2	C	1	Total	C	O	0	0
			88	48	40		
2	D	1	Total	C	O	0	0
			88	48	40		
2	D	1	Total	C	O	0	0
			88	48	40		

- Molecule 3 is GLYCEROL (three-letter code: GOL) (formula:  $C_3H_8O_3$ ).



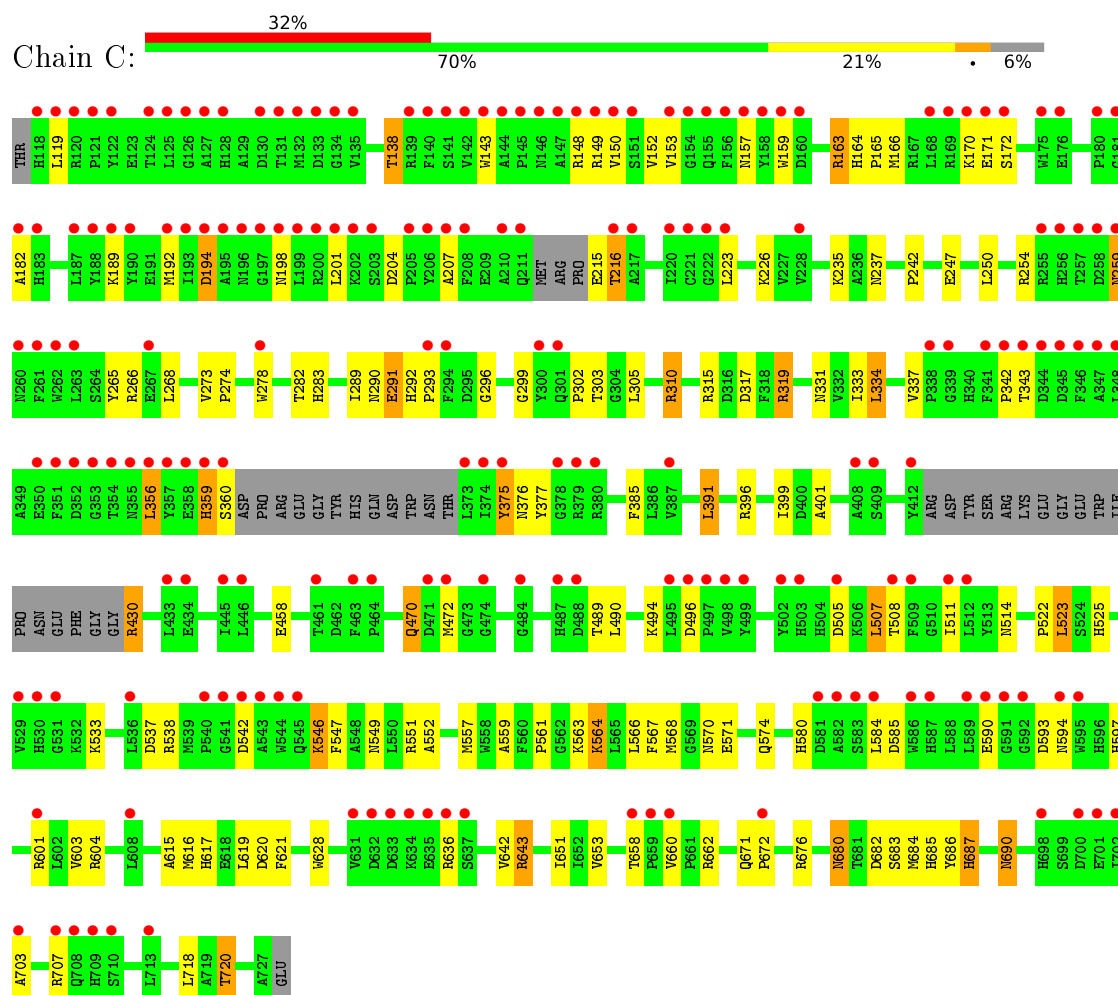
Mol	Chain	Residues	Atoms			ZeroOcc	AltConf
3	A	1	Total	C	O	0	0
			6	3	3		
3	A	1	Total	C	O	0	0
			6	3	3		
3	B	1	Total	C	O	0	0
			6	3	3		
3	B	1	Total	C	O	0	0
			6	3	3		
3	D	1	Total	C	O	0	0
			6	3	3		
3	D	1	Total	C	O	0	0
			6	3	3		

- Molecule 4 is water.

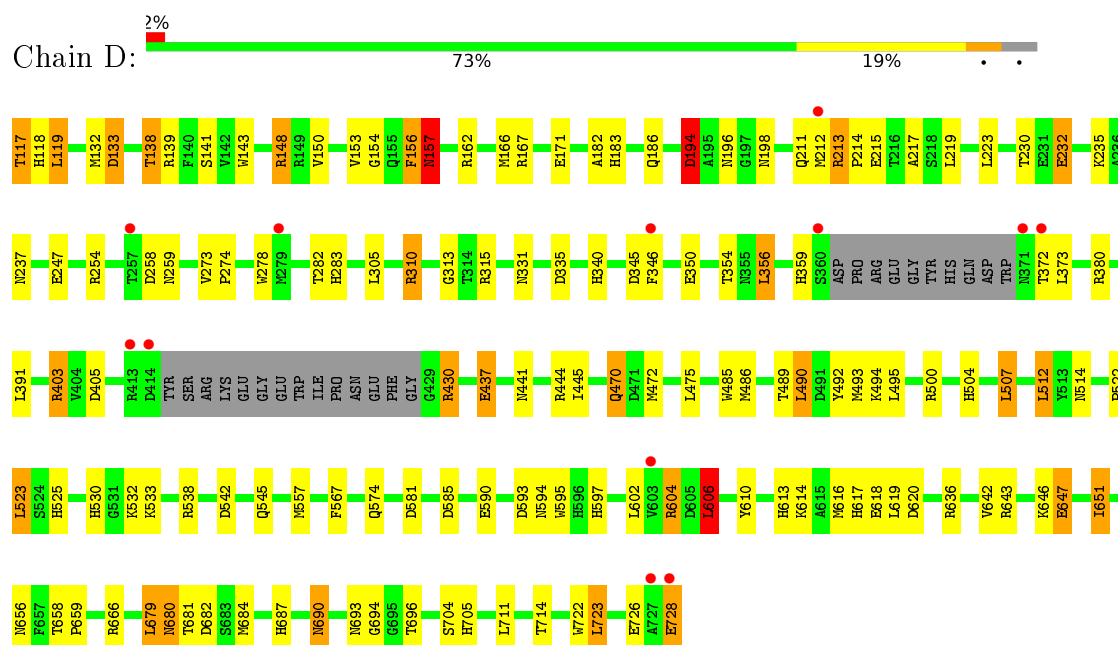
Mol	Chain	Residues	Atoms		ZeroOcc	AltConf
4	A	310	Total 310	O 310	0	0
4	B	480	Total 480	O 480	0	0
4	C	75	Total 75	O 75	0	0
4	D	340	Total 340	O 340	0	0



• Molecule 1: 1,4-alpha-glucan branching enzyme GlgB



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## 4 Data and refinement statistics

Property	Value	Source
Space group	P 1 21 1	Depositor
Cell constants a, b, c, $\alpha$ , $\beta$ , $\gamma$	92.10 Å 103.22 Å 186.69 Å 90.00° 91.73° 90.00°	Depositor
Resolution (Å)	50.00 – 2.33 45.60 – 2.33	Depositor EDS
% Data completeness (in resolution range)	94.6 (50.00-2.33) 94.6 (45.60-2.33)	Depositor EDS
$R_{merge}$	(Not available)	Depositor
$R_{sym}$	(Not available)	Depositor
$\langle I/\sigma(I) \rangle$ <sup>1</sup>	4.10 (at 2.34 Å)	Xtriage
Refinement program	REFMAC 5.5.0102	Depositor
R, $R_{free}$	0.170 , 0.217 0.167 , 0.213	Depositor DCC
$R_{free}$ test set	14049 reflections (11.11%)	DCC
Wilson B-factor (Å <sup>2</sup> )	38.6	Xtriage
Anisotropy	0.076	Xtriage
Bulk solvent $k_{sol}$ (e/Å <sup>3</sup> ), $B_{sol}$ (Å <sup>2</sup> )	0.34 , 53.6	EDS
L-test for twinning <sup>2</sup>	$\langle  L  \rangle = 0.47$ , $\langle L^2 \rangle = 0.30$	Xtriage
Estimated twinning fraction	0.029 for h,-k,-l	Xtriage
$F_o, F_c$ correlation	0.96	EDS
Total number of atoms	21132	wwPDB-VP
Average B, all atoms (Å <sup>2</sup> )	51.0	wwPDB-VP

Xtriage's analysis on translational NCS is as follows: *The largest off-origin peak in the Patterson function is 2.93% 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, 0.375 respectively for untwinned datasets, and 0.333, 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: RCD, GOL

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	0.65	0/5028	0.68	5/6827 (0.1%)
1	B	0.77	0/5120	0.77	7/6953 (0.1%)
1	C	0.40	0/4918	0.51	0/6677
1	D	0.65	0/5006	0.73	8/6796 (0.1%)
All	All	0.64	0/20072	0.68	20/27253 (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	D	0	1

There are no bond length outliers.

The worst 5 of 20 bond angle outliers are listed below:

Mol	Chain	Res	Type	Atoms	Z	Observed(°)	Ideal(°)
1	B	538	ARG	NE-CZ-NH2	-8.43	116.09	120.30
1	B	723	LEU	CA-CB-CG	7.54	132.64	115.30
1	A	723	LEU	CA-CB-CG	6.89	131.15	115.30
1	D	723	LEU	CA-CB-CG	6.65	130.59	115.30
1	D	403	ARG	NE-CZ-NH1	-6.46	117.07	120.30

There are no chirality outliers.

All (1) planarity outliers are listed below:

Mol	Chain	Res	Type	Group
1	D	156	PHE	Peptide

## 5.2 Too-close contacts ⓘ

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	4871	0	4596	131	0
1	B	4960	0	4666	109	0
1	C	4768	0	4505	111	0
1	D	4852	0	4584	119	1
2	A	88	0	80	15	0
2	B	88	0	80	1	0
2	C	88	0	80	2	0
2	D	176	0	160	4	1
3	A	12	0	16	3	0
3	B	12	0	16	2	0
3	D	12	0	16	1	0
4	A	310	0	0	17	0
4	B	480	0	0	17	0
4	C	75	0	0	8	0
4	D	340	0	0	19	0
All	All	21132	0	18799	479	1

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 12.

The worst 5 of 479 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:211:GLN:NE2	1:A:217:ALA:HB3	1.54	1.21
1:D:117:THR:N	1:D:118:HIS:HB2	1.56	1.21
1:D:470:GLN:H	1:D:470:GLN:NE2	1.45	1.13
1:D:470:GLN:N	1:D:470:GLN:HE21	1.48	1.12
1:D:213:ARG:H	1:D:213:ARG:HD3	1.16	1.03

All (1) 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)
1:D:133:ASP:OD1	2:D:801:RCD:O6D[2_655]	2.18	0.02

## 5.3 Torsion angles ⓘ

### 5.3.1 Protein backbone ⓘ

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	586/612 (96%)	557 (95%)	25 (4%)	4 (1%)	26	28
1	B	596/612 (97%)	580 (97%)	13 (2%)	3 (0%)	34	37
1	C	572/612 (94%)	538 (94%)	30 (5%)	4 (1%)	26	28
1	D	584/612 (95%)	558 (96%)	22 (4%)	4 (1%)	26	28
All	All	2338/2448 (96%)	2233 (96%)	90 (4%)	15 (1%)	30	32

5 of 15 Ramachandran outliers are listed below:

Mol	Chain	Res	Type
1	A	214	PRO
1	A	215	GLU
1	C	216	THR
1	D	194	ASP
1	B	355	ASN

### 5.3.2 Protein sidechains ⓘ

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	504/521 (97%)	467 (93%)	37 (7%)	17	18
1	B	512/521 (98%)	470 (92%)	42 (8%)	14	14
1	C	492/521 (94%)	451 (92%)	41 (8%)	14	14
1	D	501/521 (96%)	459 (92%)	42 (8%)	14	14
All	All	2009/2084 (96%)	1847 (92%)	162 (8%)	15	15

5 of 162 residues with a non-rotameric sidechain are listed below:

Mol	Chain	Res	Type
1	B	619	LEU
1	C	291	GLU
1	D	581	ASP
1	B	656	ASN
1	C	163	ARG

Some sidechains can be flipped to improve hydrogen bonding and reduce clashes. 5 of 109 such sidechains are listed below:

Mol	Chain	Res	Type
1	B	617	HIS
1	C	301	GLN
1	D	617	HIS
1	B	656	ASN
1	B	709	HIS

### 5.3.3 RNA ⓘ

There are no RNA molecules in this entry.

## 5.4 Non-standard residues in protein, DNA, RNA chains ⓘ

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

## 5.5 Carbohydrates ⓘ

There are no carbohydrates in this entry.

## 5.6 Ligand geometry ⓘ

11 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
2	RCD	A	801	-	96,96,96	0.55	0	144,144,144	1.17	10 (6%)
3	GOL	A	802	-	5,5,5	0.34	0	5,5,5	1.13	1 (20%)
3	GOL	A	803	-	5,5,5	0.45	0	5,5,5	0.69	0
2	RCD	B	801	-	96,96,96	0.52	0	144,144,144	1.04	8 (5%)
3	GOL	B	802	-	5,5,5	0.38	0	5,5,5	0.71	0
3	GOL	B	803	-	5,5,5	0.50	0	5,5,5	0.44	0
2	RCD	C	801	-	96,96,96	0.40	0	144,144,144	0.89	3 (2%)
2	RCD	D	801	-	96,96,96	0.49	0	144,144,144	1.04	11 (7%)
2	RCD	D	802	-	96,96,96	0.45	0	144,144,144	0.94	5 (3%)
3	GOL	D	803	-	5,5,5	0.34	0	5,5,5	0.56	0
3	GOL	D	804	-	5,5,5	0.44	0	5,5,5	0.25	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
2	RCD	A	801	-	-	0/48/208/208	0/0/9/9
3	GOL	A	802	-	-	0/4/4/4	0/0/0/0
3	GOL	A	803	-	-	0/4/4/4	0/0/0/0
2	RCD	B	801	-	-	0/48/208/208	0/0/9/9
3	GOL	B	802	-	-	0/4/4/4	0/0/0/0
3	GOL	B	803	-	-	0/4/4/4	0/0/0/0
2	RCD	C	801	-	-	0/48/208/208	0/0/9/9
2	RCD	D	801	-	-	0/48/208/208	0/0/9/9
2	RCD	D	802	-	-	0/48/208/208	0/0/9/9
3	GOL	D	803	-	-	0/4/4/4	0/0/0/0
3	GOL	D	804	-	-	0/4/4/4	0/0/0/0

There are no bond length outliers.

The worst 5 of 38 bond angle outliers are listed below:

Mol	Chain	Res	Type	Atoms	Z	Observed(°)	Ideal(°)
2	B	801	RCD	C1E-O4F-C4F	-2.87	110.37	118.00
2	D	801	RCD	C1H-O4A-C4A	-2.65	110.95	118.00
2	D	801	RCD	O5B-C1B-C2B	-2.49	105.11	110.28
2	A	801	RCD	C1F-O4G-C4G	-2.47	111.43	118.00
2	B	801	RCD	C1D-O5D-C5D	-2.43	108.98	113.74

There are no chirality outliers.

There are no torsion outliers.

There are no ring outliers.

8 monomers are involved in 29 short contacts:

Mol	Chain	Res	Type	Clashes	Symm-Clashes
2	A	801	RCD	15	0
3	A	802	GOL	3	0
2	B	801	RCD	1	0
3	B	803	GOL	2	0
2	C	801	RCD	2	0
2	D	801	RCD	1	1
2	D	802	RCD	3	0
3	D	803	GOL	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	586/612 (95%)	0.38	66 (11%) <b>7</b> <b>12</b>	19, 38, 105, 134	7 (1%)
1	B	600/612 (98%)	-0.01	4 (0%) <b>89</b> <b>93</b>	16, 31, 56, 75	6 (1%)
1	C	578/612 (94%)	1.59	193 (33%) <b>0</b> <b>0</b>	49, 79, 117, 140	2 (0%)
1	D	588/612 (96%)	-0.07	12 (2%) <b>68</b> <b>79</b>	24, 38, 60, 84	4 (0%)
All	All	2352/2448 (96%)	0.46	275 (11%) <b>6</b> <b>10</b>	16, 41, 102, 140	19 (0%)

The worst 5 of 275 RSRZ outliers are listed below:

Mol	Chain	Res	Type	RSRZ
1	C	360	SER	9.5
1	C	133	ASP	9.0
1	C	132	MET	8.2
1	C	343	THR	7.7
1	C	499	TYR	7.5

### 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 carbohydrates 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. LLDF column lists the quality of electron density of the group with respect to its neighbouring residues in protein, DNA or RNA chains. 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	LLDF	B-factors( $\text{\AA}^2$ )	Q<0.9
3	GOL	A	802	6/6	0.92	0.20	8.12	42,44,44,46	0
2	RCD	B	801	88/88	0.88	0.20	4.10	32,60,72,73	20
2	RCD	C	801	88/88	0.59	0.51	2.55	96,100,104,104	77
3	GOL	A	803	6/6	0.96	0.19	2.43	27,31,32,34	0
3	GOL	B	803	6/6	0.94	0.14	2.09	45,45,45,46	0
2	RCD	D	801	88/88	0.87	0.20	2.07	42,63,69,70	0
2	RCD	D	802	88/88	0.76	0.30	1.44	75,87,92,92	35
2	RCD	A	801	88/88	0.80	0.23	1.32	45,71,79,79	34
3	GOL	D	804	6/6	0.96	0.13	0.40	45,45,46,48	0
3	GOL	B	802	6/6	0.95	0.17	0.13	30,34,35,36	0
3	GOL	D	803	6/6	0.94	0.16	0.11	50,53,53,53	0

## 6.5 Other polymers [i](#)

There are no such residues in this entry.