



# wwPDB X-ray Structure Validation Summary Report ⓘ

Aug 30, 2017 – 05:33 PM EDT

PDB ID : 4XOT  
Title : Tailspike protein mutant E372Q of E. coli bacteriophage HK620 in complex with pentasaccharide  
Authors : Gohlke, U.; Broecker, N.K.; Heinemann, U.; Seckler, R.; Barbirz, S.  
Deposited on : unknown  
Resolution : 1.06 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.

---

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

MolProbity : 4.02b-467  
Mogul : 1.7.2 (RC1), CSD as538be (2017)  
Xtriage (Phenix) : 1.9-1692  
EDS : rb-20029824  
Percentile statistics : 20161228.v01 (using entries in the PDB archive December 28th 2016)  
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-20029824

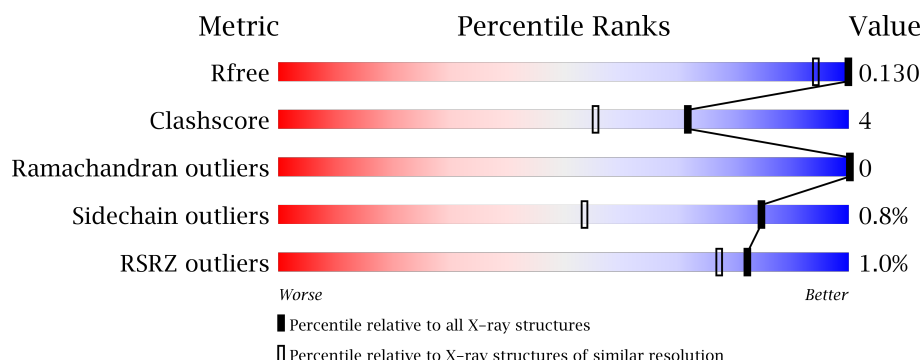
# 1 Overall quality at a glance

The following experimental techniques were used to determine the structure:

## *X-RAY DIFFRACTION*

The reported resolution of this entry is 1.06 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))
$R_{free}$	100719	1262 (1.12-1.00)
Clashscore	112137	1336 (1.12-1.00)
Ramachandran outliers	110173	1269 (1.12-1.00)
Sidechain outliers	110143	1267 (1.12-1.00)
RSRZ outliers	101464	1268 (1.12-1.00)

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	597	<div> <div style="width: 100%; height: 10px; position: relative;"> <div style="position: absolute; top: -10px; left: 0; right: 0; text-align: center;">%</div> <div style="position: absolute; top: 0; left: 0; width: 100%; height: 100%; background: linear-gradient(to right, red 0%, red 10%, orange 10%, orange 20%, yellow 20%, yellow 30%, green 30%, green 90%, yellow 90%, orange 90%, red 90%, red 100%);"></div> <div style="position: absolute; bottom: -10px; left: 0; right: 0; text-align: center;">90% 9%</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 criteria:

Mol	Type	Chain	Res	Chirality	Geometry	Clashes	Electron density
8	FMT	A	1008	-	-	-	X
8	FMT	A	1011	-	-	X	X

*Continued on next page...*

*Continued from previous page...*

Mol	Type	Chain	Res	Chirality	Geometry	Clashes	Electron density
8	FMT	A	1012	-	-	-	X

## 2 Entry composition [i](#)

There are 10 unique types of molecules in this entry. The entry contains 5778 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.

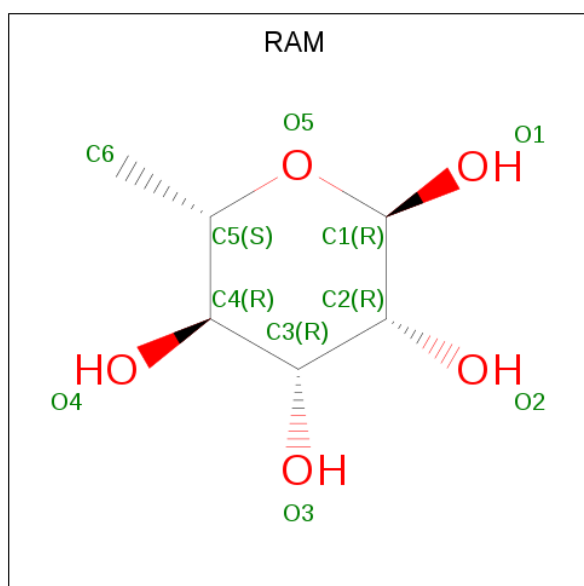
- Molecule 1 is a protein called Tail spike protein.

Mol	Chain	Residues	Atoms					ZeroOcc	AltConf	Trace
			Total	C	N	O	S			
1	A	597	4823	3005	835	959	24	0	39	0

There is a discrepancy between the modelled and reference sequences:

Chain	Residue	Modelled	Actual	Comment	Reference
A	372	GLN	GLU	engineered mutation	UNP Q9AYY6

- Molecule 2 is ALPHA-L-RHAMNOSE (three-letter code: RAM) (formula:  $C_6H_{12}O_5$ ).



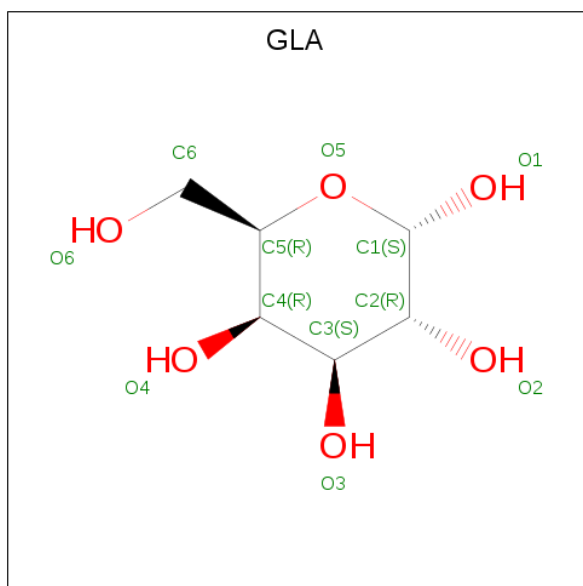
Mol	Chain	Residues	Atoms			ZeroOcc	AltConf
			Total	C	O		
2	A	1	10	6	4	0	0

- Molecule 3 is ALPHA-D-GLUCOSE (three-letter code: GLC) (formula:  $C_6H_{12}O_6$ ).



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

- Molecule 4 is ALPHA D-GALACTOSE (three-letter code: GLA) (formula:  $C_6H_{12}O_6$ ).



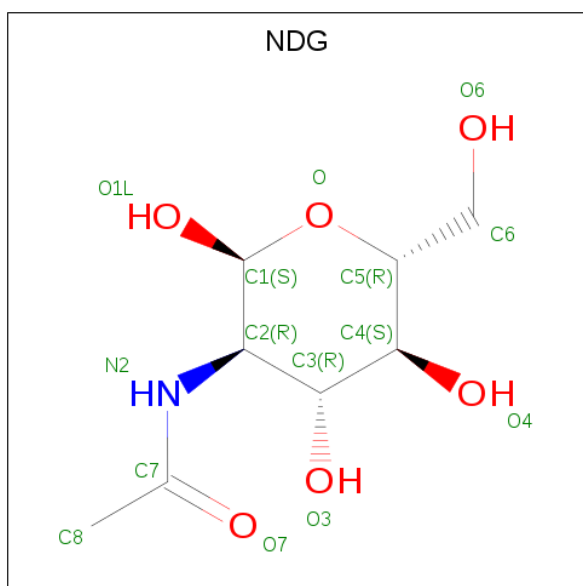
Mol	Chain	Residues	Atoms			ZeroOcc	AltConf
4	A	1	Total	C	O	0	0
			12	6	6		

- Molecule 5 is N-ACETYL-D-GLUCOSAMINE (three-letter code: NAG) (formula:  $C_8H_{15}NO_6$ ).



Mol	Chain	Residues	Atoms				ZeroOcc	AltConf
5	A	1	Total	C	N	O	0	0
			14	8	1	5		

- Molecule 6 is 2-(ACETYLAMINO)-2-DEOXY-A-D-GLUCOPYRANOSE (three-letter code: NDG) (formula:  $C_8H_{15}NO_6$ ).



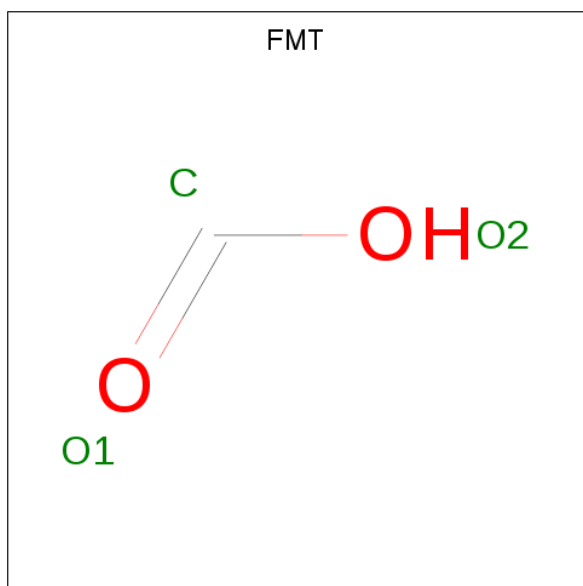
Mol	Chain	Residues	Atoms				ZeroOcc	AltConf
6	A	1	Total	C	N	O	0	1
			28	16	2	10		

- Molecule 7 is 2-AMINO-2-HYDROXYMETHYL-PROPANE-1,3-DIOL (three-letter code: TRS) (formula:  $C_4H_{12}NO_3$ ).



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

- Molecule 8 is FORMIC ACID (three-letter code: FMT) (formula: CH<sub>2</sub>O<sub>2</sub>).



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

*Continued on next page...*

*Continued from previous page...*

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

- Molecule 9 is SODIUM ION (three-letter code: NA) (formula: Na).

Mol	Chain	Residues	Atoms		ZeroOcc	AltConf
9	A	2	Total	Na	0	0
			2	2		

- Molecule 10 is water.

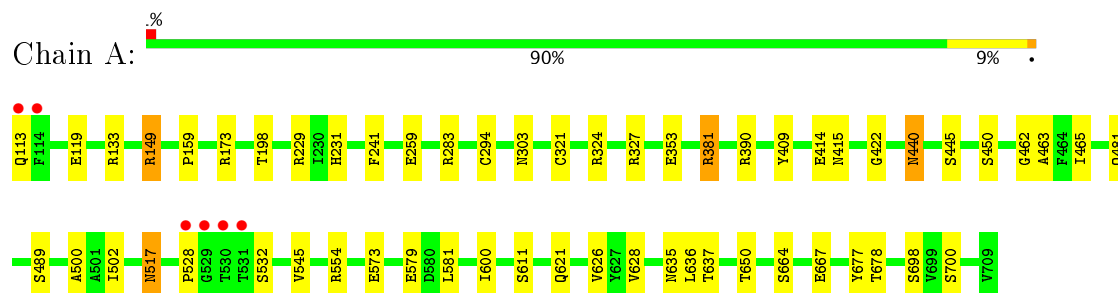
Mol	Chain	Residues	Atoms		ZeroOcc	AltConf
10	A	852	Total	O	0	38
			852	852		



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

These plots are drawn for all protein, RNA and DNA 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 ( $\text{RSRZ} > 2$ ). 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: Tail spike protein



## 4 Data and refinement statistics

Property	Value	Source
Space group	P 3 2 1	Depositor
Cell constants a, b, c, $\alpha$ , $\beta$ , $\gamma$	74.18Å 74.18Å 174.68Å 90.00° 90.00° 120.00°	Depositor
Resolution (Å)	43.67 – 1.06 37.09 – 1.06	Depositor EDS
% Data completeness (in resolution range)	99.3 (43.67-1.06) 99.3 (37.09-1.06)	Depositor EDS
$R_{merge}$	0.06	Depositor
$R_{sym}$	(Not available)	Depositor
$\langle I/\sigma(I) \rangle$ <sup>1</sup>	1.66 (at 1.06Å)	Xtriage
Refinement program	REFMAC 5.8.0069	Depositor
R, $R_{free}$	0.105 , 0.130 0.107 , 0.130	Depositor DCC
$R_{free}$ test set	12508 reflections (5.26%)	DCC
Wilson B-factor (Å <sup>2</sup> )	8.5	Xtriage
Anisotropy	0.194	Xtriage
Bulk solvent $k_{sol}$ (e/Å <sup>3</sup> ), $B_{sol}$ (Å <sup>2</sup> )	0.34 , 45.2	EDS
L-test for twinning <sup>2</sup>	$\langle  L  \rangle = 0.47$ , $\langle L^2 \rangle = 0.30$	Xtriage
Estimated twinning fraction	0.027 for -h,-k,l	Xtriage
$F_o, F_c$ correlation	0.98	EDS
Total number of atoms	5778	wwPDB-VP
Average B, all atoms (Å <sup>2</sup> )	12.0	wwPDB-VP

Xtriage's analysis on translational NCS is as follows: *The largest off-origin peak in the Patterson function is 3.94% 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

### 5.1 Standard geometry

Bond lengths and bond angles in the following residue types are not validated in this section: RAM, NAG, GLA, FMT, GLC, NDG, NA, 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	1.00	11/4931 (0.2%)	1.02	14/6717 (0.2%)

The worst 5 of 11 bond length outliers are listed below:

Mol	Chain	Res	Type	Atoms	Z	Observed(Å)	Ideal(Å)
1	A	667	GLU	CD-OE2	10.71	1.37	1.25
1	A	664	SER	CB-OG	-8.29	1.31	1.42
1	A	353	GLU	CG-CD	7.49	1.63	1.51
1	A	113	GLN	C-O	-7.24	1.09	1.23
1	A	353	GLU	CB-CG	-6.79	1.39	1.52

The worst 5 of 14 bond angle outliers are listed below:

Mol	Chain	Res	Type	Atoms	Z	Observed( $^{\circ}$ )	Ideal( $^{\circ}$ )
1	A	229	ARG	NE-CZ-NH2	-17.36	111.62	120.30
1	A	229	ARG	NE-CZ-NH1	9.07	124.84	120.30
1	A	149	ARG	NE-CZ-NH2	-7.59	116.51	120.30
1	A	381[A]	ARG	NE-CZ-NH2	-6.87	116.86	120.30
1	A	381[B]	ARG	NE-CZ-NH2	-6.87	116.86	120.30

There are no chirality outliers.

There are no planarity outliers.

### 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	4823	0	4514	36	0
2	A	10	0	8	0	0
3	A	11	0	9	0	0
4	A	12	0	9	0	0
5	A	14	0	13	0	0
6	A	28	0	26	0	0
7	A	8	0	12	0	0
8	A	18	0	7	4	0
9	A	2	0	0	0	0
10	A	852	0	0	17	6
All	All	5778	0	4598	38	6

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 4.

The worst 5 of 38 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:231[B]:HIS:NE2	10:A:1108:HOH:O	1.84	1.07
8:A:1011:FMT:O2	10:A:1104[B]:HOH:O	1.70	1.07
1:A:303[B]:ASN:OD1	10:A:1103:HOH:O	1.68	1.06
1:A:528:PRO:HD3	10:A:1387:HOH:O	1.54	1.05
1:A:573[B]:GLU:OE2	10:A:1105:HOH:O	1.74	1.04

The worst 5 of 6 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)
10:A:1346:HOH:O	10:A:1396:HOH:O[3_675]	1.79	0.41
10:A:1483:HOH:O	10:A:1512:HOH:O[2_655]	1.82	0.38
10:A:1889:HOH:O	10:A:1889:HOH:O[6_765]	2.00	0.20
10:A:1545:HOH:O	10:A:1571:HOH:O[6_766]	2.10	0.10
10:A:1113:HOH:O	10:A:1576:HOH:O[2_655]	2.15	0.05

## 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	634/597 (106%)	619 (98%)	15 (2%)	0	100	100

There are no Ramachandran outliers to report.

### 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	528/489 (108%)	522 (99%)	6 (1%)	78	43

5 of 6 residues with a non-rotameric sidechain are listed below:

Mol	Chain	Res	Type
1	A	489[A]	SER
1	A	517[B]	ASN
1	A	489[B]	SER
1	A	440	ASN
1	A	517[A]	ASN

Some sidechains can be flipped to improve hydrogen bonding and reduce clashes. There are no such sidechains identified.

### 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 ⓘ

Of 15 ligands modelled in this entry, 2 are monoatomic - leaving 13 for Mogul analysis.

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	RAM	A	1001	9,3	9,10,11	1.13	0	13,14,16	0.68	0
3	GLC	A	1002	2,4	11,11,12	0.63	0	13,15,17	1.15	1 (7%)
4	GLA	A	1003	3,5,6	12,12,12	0.56	0	17,17,17	0.57	0
5	NAG	A	1004	4	14,14,15	0.68	0	15,19,21	1.12	1 (6%)
6	NDG	A	1005[A]	4	14,14,15	1.20	2 (14%)	16,19,21	0.80	0
6	NDG	A	1005[B]	4	14,14,15	0.78	0	16,19,21	0.75	0
7	TRS	A	1006	-	7,7,7	0.79	0	9,9,9	1.09	1 (11%)
8	FMT	A	1007	-	0,2,2	0.00	-	0,1,1	0.00	-
8	FMT	A	1008	-	0,2,2	0.00	-	0,1,1	0.00	-
8	FMT	A	1009	-	0,2,2	0.00	-	0,1,1	0.00	-
8	FMT	A	1010	-	0,2,2	0.00	-	0,1,1	0.00	-
8	FMT	A	1011	-	0,2,2	0.00	-	0,1,1	0.00	-
8	FMT	A	1012	-	0,2,2	0.00	-	0,1,1	0.00	-

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	RAM	A	1001	9,3	-	0/0/17/20	0/1/1/1
3	GLC	A	1002	2,4	-	0/2/19/22	0/1/1/1
4	GLA	A	1003	3,5,6	-	0/2/22/22	0/1/1/1
5	NAG	A	1004	4	-	0/6/23/26	0/1/1/1
6	NDG	A	1005[A]	4	-	0/6/22/26	0/1/1/1
6	NDG	A	1005[B]	4	-	0/6/22/26	0/1/1/1

*Continued on next page...*

*Continued from previous page...*

Mol	Type	Chain	Res	Link	Chirals	Torsions	Rings
7	TRS	A	1006	-	-	0/9/9/9	0/0/0/0
8	FMT	A	1007	-	-	0/0/0/0	0/0/0/0
8	FMT	A	1008	-	-	0/0/0/0	0/0/0/0
8	FMT	A	1009	-	-	0/0/0/0	0/0/0/0
8	FMT	A	1010	-	-	0/0/0/0	0/0/0/0
8	FMT	A	1011	-	-	0/0/0/0	0/0/0/0
8	FMT	A	1012	-	-	0/0/0/0	0/0/0/0

All (2) bond length outliers are listed below:

Mol	Chain	Res	Type	Atoms	Z	Observed(Å)	Ideal(Å)
6	A	1005[A]	NDG	O-C1	-2.19	1.39	1.43
6	A	1005[A]	NDG	C1-C2	3.28	1.56	1.52

All (3) bond angle outliers are listed below:

Mol	Chain	Res	Type	Atoms	Z	Observed(°)	Ideal(°)
7	A	1006	TRS	C3-C-N	2.12	112.24	107.73
5	A	1004	NAG	O7-C7-C8	2.35	126.34	122.06
3	A	1002	GLC	C1-C2-C3	3.07	113.55	109.65

There are no chirality outliers.

There are no torsion outliers.

There are no ring outliers.

2 monomers are involved in 4 short contacts:

Mol	Chain	Res	Type	Clashes	Symm-Clashes
8	A	1010	FMT	1	0
8	A	1011	FMT	3	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	597/597 (100%)	-0.52	6 (1%) 82 77	6, 9, 17, 78	0

The worst 5 of 6 RSRZ outliers are listed below:

Mol	Chain	Res	Type	RSRZ
1	A	529	GLY	4.4
1	A	530	THR	3.5
1	A	113	GLN	3.2
1	A	531	THR	2.8
1	A	528	PRO	2.4

### 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(Å <sup>2</sup> )	Q<0.9
8	FMT	A	1011	3/3	0.97	0.24	24.94	17,17,28,30	0

*Continued on next page...*



*Continued from previous page...*

Mol	Type	Chain	Res	Atoms	RSCC	RSR	LLDF	B-factors( $\text{\AA}^2$ )	Q<0.9
8	FMT	A	1012	3/3	0.98	0.17	6.90	20,20,21,34	0
8	FMT	A	1008	3/3	0.97	0.13	5.26	20,20,28,34	0
9	NA	A	1014	1/1	1.00	0.09	1.46	13,13,13,13	0
7	TRS	A	1006	8/8	0.98	0.06	1.36	10,11,12,13	0
6	NDG	A	1005[A]	14/15	0.98	0.06	0.98	7,8,10,13	14
6	NDG	A	1005[B]	14/15	0.98	0.06	0.98	7,8,13,13	14
5	NAG	A	1004	14/15	0.98	0.04	0.47	8,9,21,23	0
8	FMT	A	1007	3/3	0.99	0.04	0.06	11,11,12,12	0
2	RAM	A	1001	10/11	0.99	0.04	-0.63	9,11,13,13	0
4	GLA	A	1003	12/12	0.99	0.04	-0.65	7,8,9,9	0
9	NA	A	1013	1/1	0.99	0.09	-	17,17,17,17	0
8	FMT	A	1010	3/3	0.82	0.16	-	33,33,49,57	0
8	FMT	A	1009	3/3	0.99	0.03	-	14,14,14,15	0
3	GLC	A	1002	11/12	0.99	0.03	-	9,11,14,14	0

## 6.5 Other polymers [i](#)

There are no such residues in this entry.