



# wwPDB X-ray Structure Validation Summary Report ⓘ

Feb 15, 2017 – 02:10 am GMT

PDB ID : 3M2P  
Title : The crystal structure of UDP-N-acetylglucosamine 4-epimerase from *Bacillus cereus*  
Authors : Zhang, Z.; Burley, S.K.; Swaminathan, S.; New York SGX Research Center for Structural Genomics (NYSGXRC)  
Deposited on : 2010-03-08  
Resolution : 2.95 Å(reported)

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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	:	1.7.2 (RC1), CSD as538be (2017)
Xtriage (Phenix)	:	1.9-1692
EDS	:	trunk28620
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)	:	recalc28949

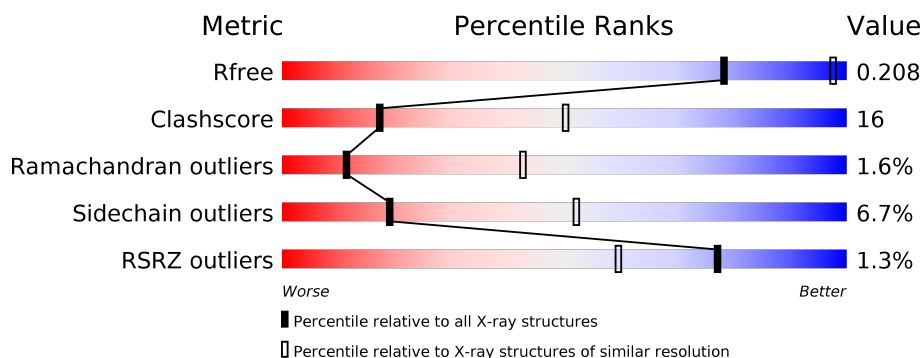
# 1 Overall quality at a glance

The following experimental techniques were used to determine the structure:

*X-RAY DIFFRACTION*

The reported resolution of this entry is 2.95 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	2395 (3.00-2.92)
Clashscore	112137	2773 (3.00-2.92)
Ramachandran outliers	110173	2680 (3.00-2.92)
Sidechain outliers	110143	2683 (3.00-2.92)
RSRZ outliers	101464	2421 (3.00-2.92)

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	311	
1	B	311	
1	C	311	
1	D	311	
1	E	311	
1	F	311	

## 2 Entry composition

There are 3 unique types of molecules in this entry. The entry contains 13067 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 UDP-N-acetylglucosamine 4-epimerase.

Mol	Chain	Residues	Atoms						ZeroOcc	AltConf	Trace
1	A	287	Total	C	N	O	S	Se	0	0	0
			2261	1428	382	444	3	4			
1	B	255	Total	C	N	O	S	Se	0	0	0
			2010	1273	334	396	3	4			
1	C	280	Total	C	N	O	S	Se	0	0	0
			2212	1399	372	434	3	4			
1	D	289	Total	C	N	O	S	Se	0	0	0
			2289	1451	382	449	3	4			
1	E	262	Total	C	N	O	S	Se	0	0	0
			2076	1317	348	404	3	4			
1	F	267	Total	C	N	O	S	Se	0	0	0
			2080	1315	346	413	3	3			

There are 66 discrepancies between the modelled and reference sequences:

Chain	Residue	Modelled	Actual	Comment	Reference
A	-1	MSE	-	EXPRESSION TAG	UNP Q814Z6
A	0	SER	-	EXPRESSION TAG	UNP Q814Z6
A	1	LEU	-	EXPRESSION TAG	UNP Q814Z6
A	302	GLU	-	EXPRESSION TAG	UNP Q814Z6
A	303	GLY	-	EXPRESSION TAG	UNP Q814Z6
A	304	HIS	-	EXPRESSION TAG	UNP Q814Z6
A	305	HIS	-	EXPRESSION TAG	UNP Q814Z6
A	306	HIS	-	EXPRESSION TAG	UNP Q814Z6
A	307	HIS	-	EXPRESSION TAG	UNP Q814Z6
A	308	HIS	-	EXPRESSION TAG	UNP Q814Z6
A	309	HIS	-	EXPRESSION TAG	UNP Q814Z6
B	-1	MSE	-	EXPRESSION TAG	UNP Q814Z6
B	0	SER	-	EXPRESSION TAG	UNP Q814Z6
B	1	LEU	-	EXPRESSION TAG	UNP Q814Z6
B	302	GLU	-	EXPRESSION TAG	UNP Q814Z6
B	303	GLY	-	EXPRESSION TAG	UNP Q814Z6
B	304	HIS	-	EXPRESSION TAG	UNP Q814Z6

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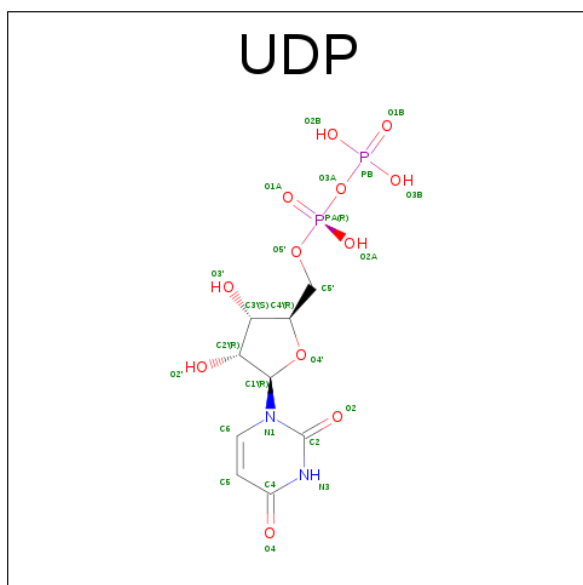
Chain	Residue	Modelled	Actual	Comment	Reference
B	305	HIS	-	EXPRESSION TAG	UNP Q814Z6
B	306	HIS	-	EXPRESSION TAG	UNP Q814Z6
B	307	HIS	-	EXPRESSION TAG	UNP Q814Z6
B	308	HIS	-	EXPRESSION TAG	UNP Q814Z6
B	309	HIS	-	EXPRESSION TAG	UNP Q814Z6
C	-1	MSE	-	EXPRESSION TAG	UNP Q814Z6
C	0	SER	-	EXPRESSION TAG	UNP Q814Z6
C	1	LEU	-	EXPRESSION TAG	UNP Q814Z6
C	302	GLU	-	EXPRESSION TAG	UNP Q814Z6
C	303	GLY	-	EXPRESSION TAG	UNP Q814Z6
C	304	HIS	-	EXPRESSION TAG	UNP Q814Z6
C	305	HIS	-	EXPRESSION TAG	UNP Q814Z6
C	306	HIS	-	EXPRESSION TAG	UNP Q814Z6
C	307	HIS	-	EXPRESSION TAG	UNP Q814Z6
C	308	HIS	-	EXPRESSION TAG	UNP Q814Z6
C	309	HIS	-	EXPRESSION TAG	UNP Q814Z6
D	-1	MSE	-	EXPRESSION TAG	UNP Q814Z6
D	0	SER	-	EXPRESSION TAG	UNP Q814Z6
D	1	LEU	-	EXPRESSION TAG	UNP Q814Z6
D	304	GLU	-	EXPRESSION TAG	UNP Q814Z6
D	305	GLY	-	EXPRESSION TAG	UNP Q814Z6
D	306	HIS	-	EXPRESSION TAG	UNP Q814Z6
D	307	HIS	-	EXPRESSION TAG	UNP Q814Z6
D	308	HIS	-	EXPRESSION TAG	UNP Q814Z6
D	309	HIS	-	EXPRESSION TAG	UNP Q814Z6
D	310	HIS	-	EXPRESSION TAG	UNP Q814Z6
D	311	HIS	-	EXPRESSION TAG	UNP Q814Z6
E	-1	MSE	-	EXPRESSION TAG	UNP Q814Z6
E	0	SER	-	EXPRESSION TAG	UNP Q814Z6
E	1	LEU	-	EXPRESSION TAG	UNP Q814Z6
E	302	GLU	-	EXPRESSION TAG	UNP Q814Z6
E	303	GLY	-	EXPRESSION TAG	UNP Q814Z6
E	304	HIS	-	EXPRESSION TAG	UNP Q814Z6
E	305	HIS	-	EXPRESSION TAG	UNP Q814Z6
E	306	HIS	-	EXPRESSION TAG	UNP Q814Z6
E	307	HIS	-	EXPRESSION TAG	UNP Q814Z6
E	308	HIS	-	EXPRESSION TAG	UNP Q814Z6
E	309	HIS	-	EXPRESSION TAG	UNP Q814Z6
F	-1	MSE	-	EXPRESSION TAG	UNP Q814Z6
F	0	SER	-	EXPRESSION TAG	UNP Q814Z6
F	1	LEU	-	EXPRESSION TAG	UNP Q814Z6
F	302	GLU	-	EXPRESSION TAG	UNP Q814Z6

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Chain	Residue	Modelled	Actual	Comment	Reference
F	303	GLY	-	EXPRESSION TAG	UNP Q814Z6
F	304	HIS	-	EXPRESSION TAG	UNP Q814Z6
F	305	HIS	-	EXPRESSION TAG	UNP Q814Z6
F	306	HIS	-	EXPRESSION TAG	UNP Q814Z6
F	307	HIS	-	EXPRESSION TAG	UNP Q814Z6
F	308	HIS	-	EXPRESSION TAG	UNP Q814Z6
F	309	HIS	-	EXPRESSION TAG	UNP Q814Z6

- Molecule 2 is URIDINE-5'-DIPHOSPHATE (three-letter code: UDP) (formula:  $C_9H_{14}N_2O_{12}P_2$ ).



Mol	Chain	Residues	Atoms					ZeroOcc	AltConf
2	B	1	Total	C	N	O	P	0	0
			25	9	2	12	2		

- Molecule 3 is water.

Mol	Chain	Residues	Atoms		ZeroOcc	AltConf
3	A	27	Total	O	0	0
			27	27		
3	B	12	Total	O	0	0
			12	12		
3	C	23	Total	O	0	0
			23	23		
3	D	22	Total	O	0	0
			22	22		
3	E	12	Total	O	0	0
			12	12		

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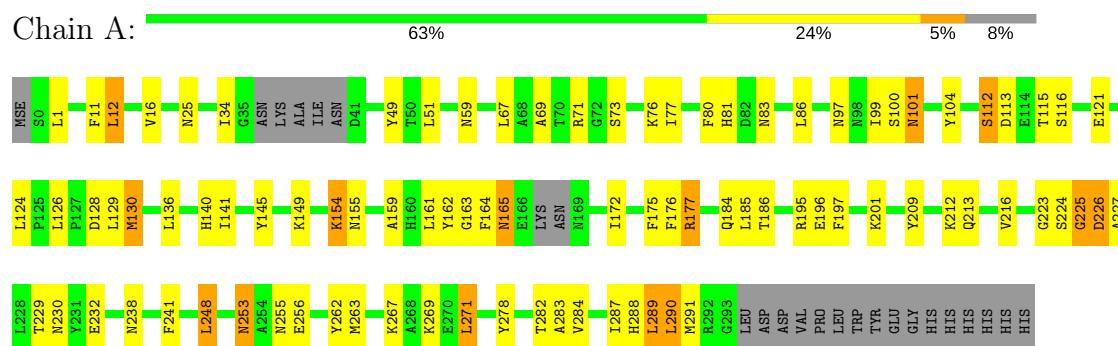
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Mol	Chain	Residues	Atoms		ZeroOcc	AltConf
3	F	18	Total	O	0	0
			18	18		

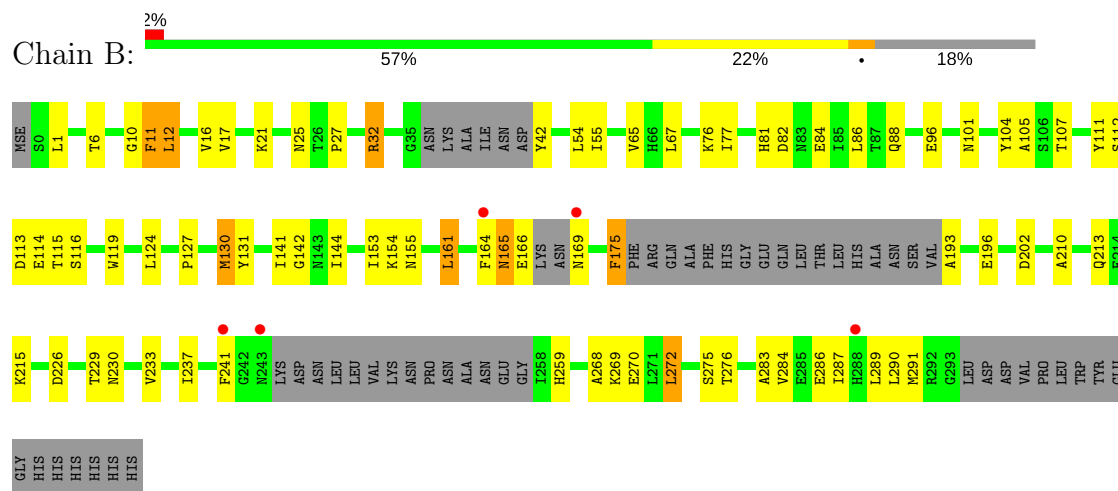
### 3 Residue-property plots [i](#)

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 ( $RSRZ > 2$ ). 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.

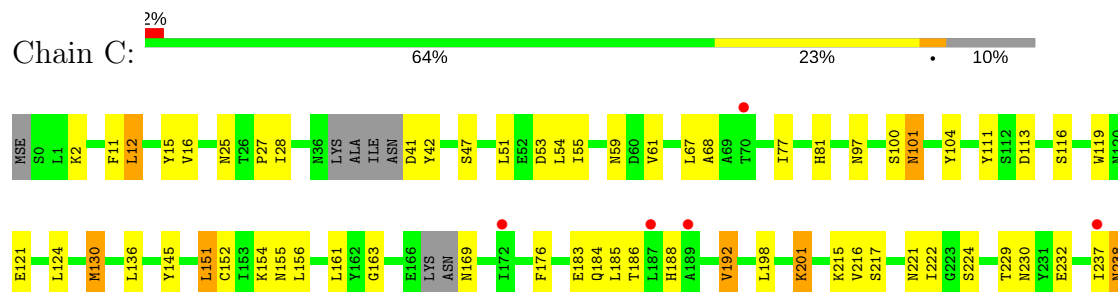
- Molecule 1: UDP-N-acetylglucosamine 4-epimerase



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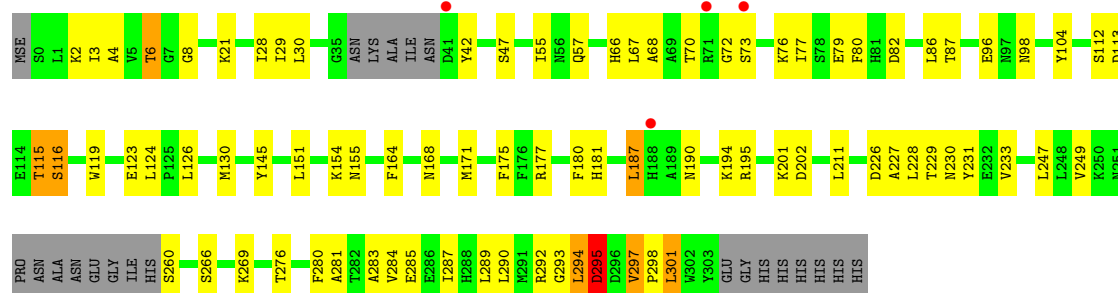


- Molecule 1: UDP-N-acetylglucosamine 4-epimerase

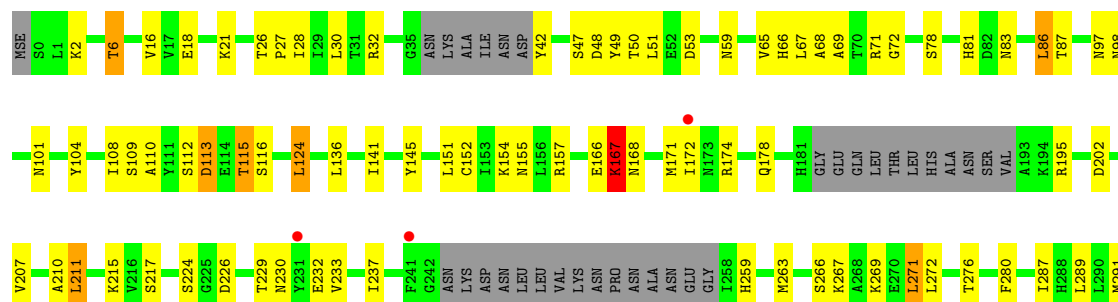




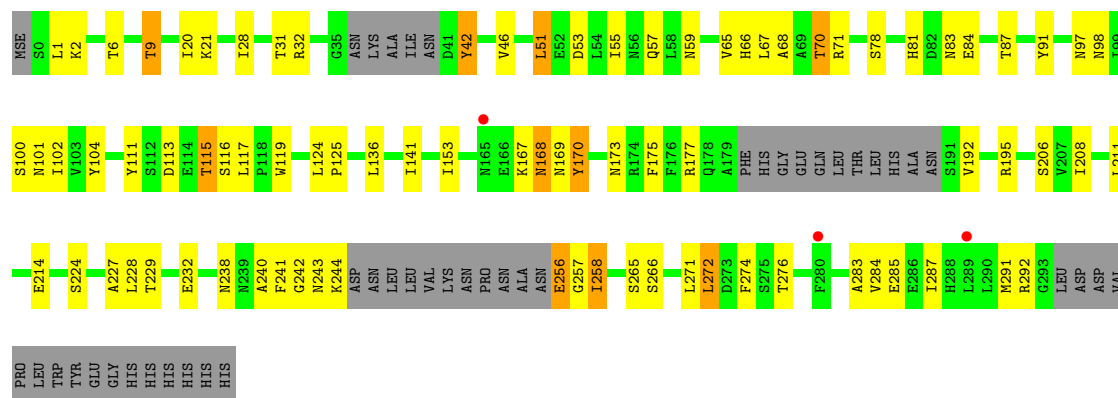
• Molecule 1: UDP-N-acetylglucosamine 4-epimerase



• Molecule 1: UDP-N-acetylglucosamine 4-epimerase



• Molecule 1: UDP-N-acetylglucosamine 4-epimerase





## 4 Data and refinement statistics

Property	Value	Source
Space group	P 21 21 21	Depositor
Cell constants a, b, c, $\alpha$ , $\beta$ , $\gamma$	104.12Å 149.72Å 166.33Å 90.00° 90.00° 90.00°	Depositor
Resolution (Å)	72.70 – 2.95 111.28 – 2.95	Depositor EDS
% Data completeness (in resolution range)	100.0 (72.70-2.95) 100.0 (111.28-2.95)	Depositor EDS
$R_{merge}$	0.14	Depositor
$R_{sym}$	(Not available)	Depositor
$\langle I/\sigma(I) \rangle$ <sup>1</sup>	4.61 (at 2.96Å)	Xtriage
Refinement program	PHENIX (phenix.refine)	Depositor
R, $R_{free}$	0.212 , 0.276 0.212 , 0.208	Depositor DCC
$R_{free}$ test set	2816 reflections (5.08%)	DCC
Wilson B-factor (Å <sup>2</sup> )	49.3	Xtriage
Anisotropy	0.534	Xtriage
Bulk solvent $k_{sol}$ (e/Å <sup>3</sup> ), $B_{sol}$ (Å <sup>2</sup> )	0.37 , 43.9	EDS
L-test for twinning <sup>2</sup>	$\langle  L  \rangle = 0.46$ , $\langle L^2 \rangle = 0.29$	Xtriage
Estimated twinning fraction	No twinning to report.	Xtriage
$F_o, F_c$ correlation	0.91	EDS
Total number of atoms	13067	wwPDB-VP
Average B, all atoms (Å <sup>2</sup> )	46.0	wwPDB-VP

Xtriage's analysis on translational NCS is as follows: *The largest off-origin peak in the Patterson function is 4.86% 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: UDP

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	0.39	0/2298	0.56	0/3101
1	B	0.37	0/2040	0.53	0/2748
1	C	0.38	0/2247	0.53	0/3030
1	D	0.42	0/2328	0.55	0/3144
1	E	0.39	0/2110	0.54	0/2842
1	F	0.39	0/2111	0.57	0/2845
All	All	0.39	0/13134	0.55	0/17710

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	2261	0	2194	96	0
1	B	2010	0	1956	62	0
1	C	2212	0	2150	62	0
1	D	2289	0	2221	74	0
1	E	2076	0	2021	57	0
1	F	2080	0	2007	74	0
2	B	25	0	10	4	0

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Mol	Chain	Non-H	H(model)	H(added)	Clashes	Symm-Clashes
3	A	27	0	0	1	0
3	B	12	0	0	0	0
3	C	23	0	0	0	0
3	D	22	0	0	1	0
3	E	12	0	0	0	0
3	F	18	0	0	1	0
All	All	13067	0	12559	396	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 16.

The worst 5 of 396 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:D:6:THR:HG21	1:D:66:HIS:HD2	1.10	1.14
1:E:6:THR:HG21	1:E:66:HIS:HD2	1.02	1.13
1:E:6:THR:HG21	1:E:66:HIS:CD2	1.88	1.06
1:C:130:MSE:HE1	1:F:141:ILE:HG12	1.38	1.05
1:D:6:THR:HG21	1:D:66:HIS:CD2	1.92	1.05

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	281/311 (90%)	254 (90%)	20 (7%)	7 (2%)	<b>6</b> 29
1	B	245/311 (79%)	225 (92%)	17 (7%)	3 (1%)	<b>15</b> 50
1	C	272/311 (88%)	249 (92%)	18 (7%)	5 (2%)	<b>10</b> 39
1	D	283/311 (91%)	266 (94%)	14 (5%)	3 (1%)	<b>17</b> 53
1	E	254/311 (82%)	235 (92%)	14 (6%)	5 (2%)	<b>9</b> 36

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Mol	Chain	Analysed	Favoured	Allowed	Outliers	Percentiles
1	F	259/311 (83%)	233 (90%)	23 (9%)	3 (1%)	15 50
All	All	1594/1866 (85%)	1462 (92%)	106 (7%)	26 (2%)	11 42

5 of 26 Ramachandran outliers are listed below:

Mol	Chain	Res	Type
1	A	226	ASP
1	B	11	PHE
1	C	188	HIS
1	D	294	LEU
1	F	168	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	244/262 (93%)	230 (94%)	14 (6%)	24 59
1	B	218/262 (83%)	205 (94%)	13 (6%)	22 57
1	C	240/262 (92%)	226 (94%)	14 (6%)	23 59
1	D	248/262 (95%)	232 (94%)	16 (6%)	20 53
1	E	224/262 (86%)	206 (92%)	18 (8%)	14 42
1	F	223/262 (85%)	205 (92%)	18 (8%)	14 42
All	All	1397/1572 (89%)	1304 (93%)	93 (7%)	19 52

5 of 93 residues with a non-rotameric sidechain are listed below:

Mol	Chain	Res	Type
1	D	30	LEU
1	D	249	VAL
1	F	192	VAL
1	D	82	ASP
1	D	154	LYS

Some sidechains can be flipped to improve hydrogen bonding and reduce clashes. 5 of 61 such sidechains are listed below:

Mol	Chain	Res	Type
1	C	184	GLN
1	D	101	ASN
1	F	155	ASN
1	C	221	ASN
1	C	238	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](#)

There are no carbohydrates in this entry.

## 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	$\# Z  > 2$
2	UDP	B	7517	-	21,26,26	4.03	12 (57%)	22,40,40	2.17	9 (40%)

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	UDP	B	7517	-	-	0/12/32/32	0/2/2/2

The worst 5 of 12 bond length outliers are listed below:

Mol	Chain	Res	Type	Atoms	Z	Observed(Å)	Ideal(Å)
2	B	7517	UDP	C3'-C4'	2.28	1.59	1.53
2	B	7517	UDP	C3'-C2'	2.50	1.60	1.53
2	B	7517	UDP	PA-O5'	2.67	1.70	1.59
2	B	7517	UDP	PB-O2B	2.79	1.66	1.54
2	B	7517	UDP	C6-C5	3.13	1.44	1.38

The worst 5 of 9 bond angle outliers are listed below:

Mol	Chain	Res	Type	Atoms	Z	Observed(°)	Ideal(°)
2	B	7517	UDP	O4'-C4'-C3'	-2.20	100.80	105.17
2	B	7517	UDP	C5'-C4'-C3'	2.29	124.00	115.29
2	B	7517	UDP	O3'-C3'-C4'	2.75	119.13	111.09
2	B	7517	UDP	O3'-C3'-C2'	2.78	120.72	111.83
2	B	7517	UDP	O4'-C4'-C5'	2.78	118.79	109.40

There are no chirality outliers.

There are no torsion outliers.

There are no ring outliers.

1 monomer is involved in 4 short contacts:

Mol	Chain	Res	Type	Clashes	Symm-Clashes
2	B	7517	UDP	4	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	283/311 (90%)	0.31	0 100 100	32, 40, 59, 71	0
1	B	251/311 (80%)	0.48	5 (1%) 65 46	37, 49, 85, 96	0
1	C	276/311 (88%)	0.37	6 (2%) 62 43	33, 43, 81, 98	0
1	D	285/311 (91%)	0.30	4 (1%) 75 58	26, 39, 54, 72	0
1	E	258/311 (82%)	0.35	3 (1%) 79 61	33, 42, 73, 80	0
1	F	263/311 (84%)	0.33	3 (1%) 80 63	30, 39, 74, 78	0
All	All	1616/1866 (86%)	0.36	21 (1%) 77 59	26, 42, 75, 98	0

The worst 5 of 21 RSRZ outliers are listed below:

Mol	Chain	Res	Type	RSRZ
1	B	164	PHE	3.3
1	C	172	ILE	2.7
1	C	187	LEU	2.6
1	C	289	LEU	2.5
1	C	237	ILE	2.5

### 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
2	UDP	B	7517	25/25	0.85	0.25	-0.02	51,55,59,62	0

## 6.5 Other polymers [i](#)

There are no such residues in this entry.