



wwPDB X-ray Structure Validation Summary Report ⓘ

Jun 13, 2024 – 12:24 AM EDT

PDB ID : 3ES8
Title : Crystal structure of divergent enolase from *Oceanobacillus Iheyensis* complexed with Mg and L-malate.
Authors : Fedorov, A.A.; Fedorov, E.V.; Sauder, J.M.; Burley, S.K.; Gerlt, J.A.; Almo, S.C.; New York SGX Research Center for Structural Genomics (NYSGXRC)
Deposited on : 2008-10-04
Resolution : 2.20 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

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 : 4.02b-467
Mogul : 2022.3.0, CSD as543be (2022)
Xtriage (Phenix) : 1.20.1
EDS : 2.36.2
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) : 2.36.2

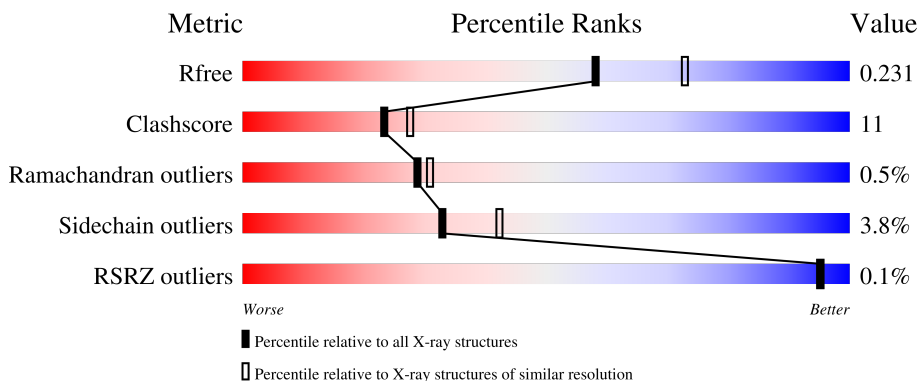
1 Overall quality at a glance

The following experimental techniques were used to determine the structure:

X-RAY DIFFRACTION

The reported resolution of this entry is 2.20 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	4898 (2.20-2.20)
Clashscore	141614	5594 (2.20-2.20)
Ramachandran outliers	138981	5503 (2.20-2.20)
Sidechain outliers	138945	5504 (2.20-2.20)
RSRZ outliers	127900	4800 (2.20-2.20)

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	391	 75% 22% ..
1	B	391	 75% 22% ..
1	C	391	 75% 22% ..
1	D	391	 75% 22% ..
1	E	391	 74% 23% ..

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Mol	Chain	Length	Quality of chain
1	F	391	 75% 23% ..
1	G	391	 75% 23% ..
1	H	391	 75% 23% ..

2 Entry composition

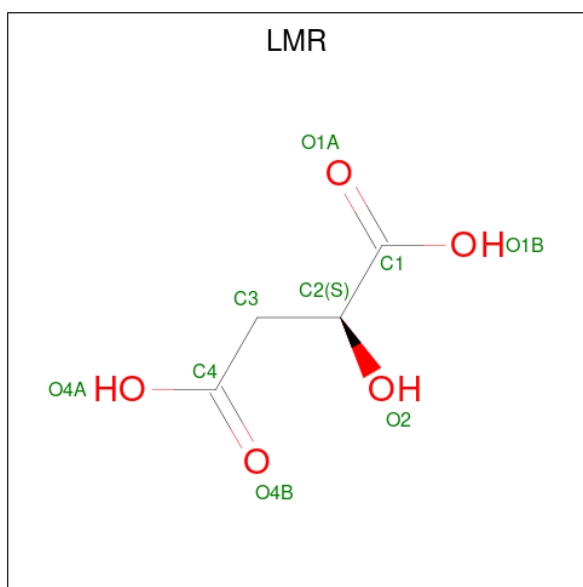
There are 4 unique types of molecules in this entry. The entry contains 25362 atoms, of which 0 are hydrogens and 0 are deuteriums.

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 Muconate cycloisomerase.

Mol	Chain	Residues	Atoms					ZeroOcc	AltConf	Trace
			Total	C	N	O	S			
1	A	387	3097	1976	525	586	10	0	0	0
1	B	387	3097	1976	525	586	10	0	0	0
1	C	387	3097	1976	525	586	10	0	0	0
1	D	387	3097	1976	525	586	10	0	0	0
1	E	387	3097	1976	525	586	10	0	0	0
1	F	387	3097	1976	525	586	10	0	0	0
1	G	387	3097	1976	525	586	10	0	0	0
1	H	387	3097	1976	525	586	10	0	0	0

- Molecule 2 is (2S)-2-hydroxybutanedioic acid (three-letter code: LMR) (formula: C₄H₆O₅).



Mol	Chain	Residues	Atoms	ZeroOcc	AltConf
2	A	1	Total C O 9 4 5	0	0
2	B	1	Total C O 9 4 5	0	0
2	C	1	Total C O 9 4 5	0	0
2	D	1	Total C O 9 4 5	0	0
2	E	1	Total C O 9 4 5	0	0
2	F	1	Total C O 9 4 5	0	0
2	G	1	Total C O 9 4 5	0	0
2	H	1	Total C O 9 4 5	0	0

- Molecule 3 is MAGNESIUM ION (three-letter code: MG) (formula: Mg).

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

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Mol	Chain	Residues	Atoms		ZeroOcc	AltConf
3	E	1	Total 1	Mg 1	0	0
3	F	1	Total 1	Mg 1	0	0
3	G	1	Total 1	Mg 1	0	0
3	H	1	Total 1	Mg 1	0	0

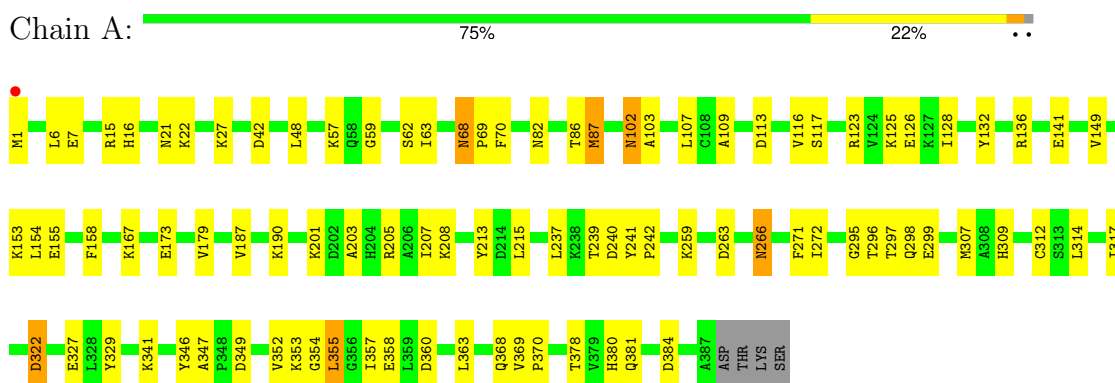
- Molecule 4 is water.

Mol	Chain	Residues	Atoms		ZeroOcc	AltConf
4	A	79	Total 79	O 79	0	0
4	B	50	Total 50	O 50	0	0
4	C	51	Total 51	O 51	0	0
4	D	64	Total 64	O 64	0	0
4	E	69	Total 69	O 69	0	0
4	F	74	Total 74	O 74	0	0
4	G	65	Total 65	O 65	0	0
4	H	54	Total 54	O 54	0	0

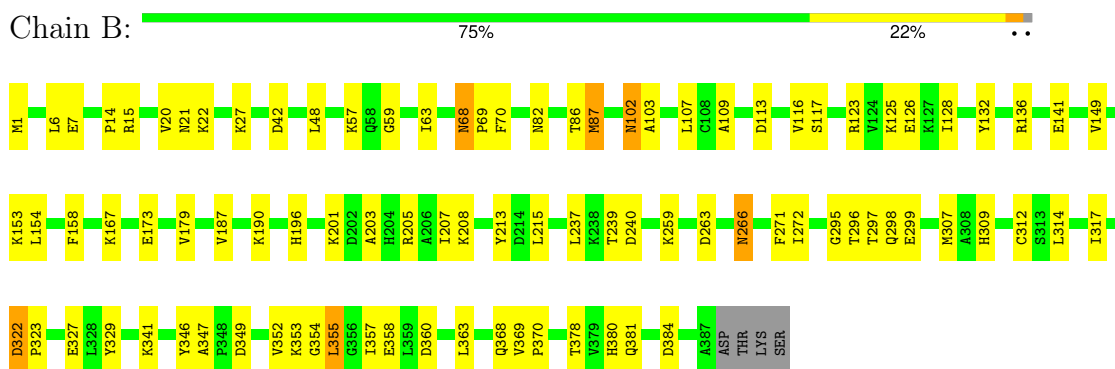
3 Residue-property plots [i](#)

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.

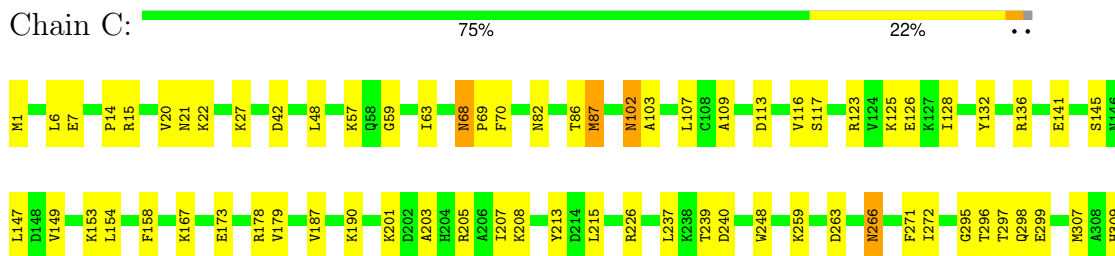
- Molecule 1: Muconate cycloisomerase



- Molecule 1: Muconate cycloisomerase



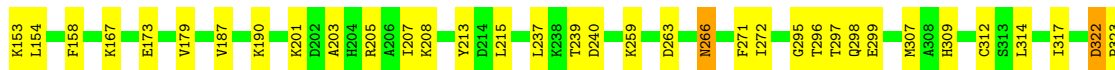
- Molecule 1: Muconate cycloisomerase





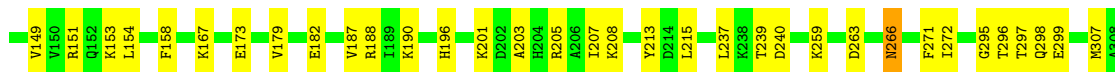
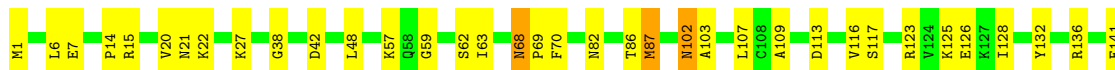
- Molecule 1: Muconate cycloisomerase

Chain D: 75% 22%



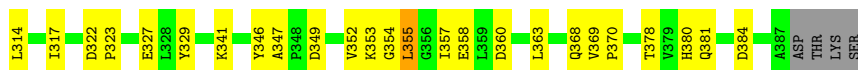
- Molecule 1: Muconate cycloisomerase

Chain E: 74% 23%



- Molecule 1: Muconate cycloisomerase

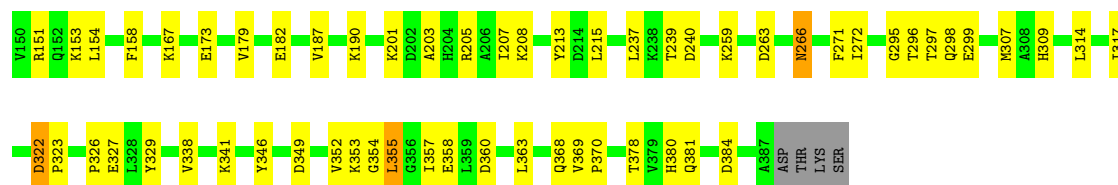
Chain F: 75% 23%



- Molecule 1: Muconate cycloisomerase

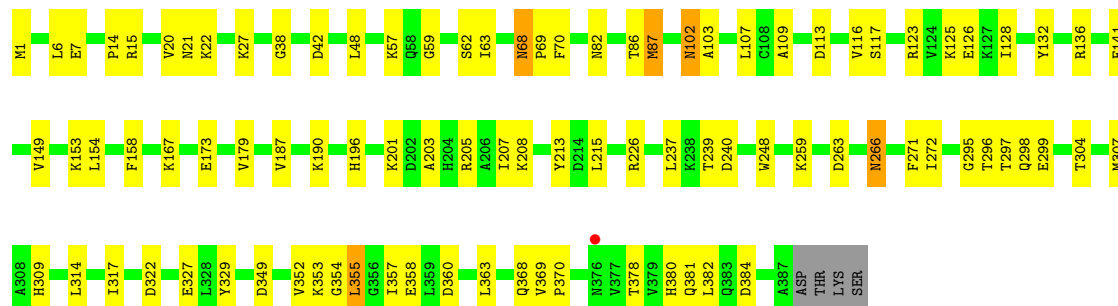
Chain G: 75% 23%





- Molecule 1: Muconate cycloisomerase

Chain H: 75% 23% ..



4 Data and refinement statistics

Property	Value	Source
Space group	P 1	Depositor
Cell constants a, b, c, α , β , γ	105.58Å 105.69Å 105.72Å 109.31° 109.47° 109.66°	Depositor
Resolution (Å)	24.94 – 2.20 38.59 – 2.19	Depositor EDS
% Data completeness (in resolution range)	95.7 (24.94-2.20) 94.6 (38.59-2.19)	Depositor EDS
R_{merge}	0.08	Depositor
R_{sym}	(Not available)	Depositor
$\langle I/\sigma(I) \rangle$ ¹	1.48 (at 2.20Å)	Xtriage
Refinement program	CNS 1.1	Depositor
R, R_{free}	0.224 , 0.241 0.214 , 0.231	Depositor DCC
R_{free} test set	8612 reflections (5.01%)	wwPDB-VP
Wilson B-factor (Å ²)	36.9	Xtriage
Anisotropy	0.066	Xtriage
Bulk solvent k_{sol} (e/Å ³), B_{sol} (Å ²)	0.32 , 24.7	EDS
L-test for twinning ²	$\langle L \rangle = 0.50$, $\langle L^2 \rangle = 0.34$	Xtriage

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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.

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Property	Value	Source
Estimated twinning fraction	0.440 for -k,h+k+1,-h 0.440 for -l,-h,h+k+1 0.002 for -l,h+k+1,-k 0.002 for h+k+1,-l,-h 0.002 for -k,-l,h+k+1 0.002 for h+k+1,-h,-k 0.000 for h,l,-h-k-l 0.000 for h,-h-k-l,k 0.001 for l,h,k 0.001 for k,l,h 0.001 for -h-k-l,k,h 0.001 for l,k,-h-k-l 0.000 for -h-k-l,h,l 0.000 for k,-h-k-l,l 0.470 for -h-k-l,l,k 0.023 for h+k+1,-k,-l 0.024 for k,h,-h-k-l 0.003 for -k,-h,-l 0.024 for l,-h-k-l,h 0.003 for -h,h+k+1,-l 0.022 for -h,-l,-k 0.002 for -h,-k,h+k+1 0.002 for -l,-k,-h	Xtriage
F_o, F_c correlation	0.95	EDS
Total number of atoms	25362	wwPDB-VP
Average B, all atoms (\AA^2)	43.0	wwPDB-VP

Xtriage's analysis on translational NCS is as follows: *The largest off-origin peak in the Patterson function is 3.65% of the height of the origin peak. No significant pseudotranslation is detected.*

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: LMR, MG

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	0.37	0/3163	0.64	0/4276
1	B	0.36	0/3163	0.63	0/4276
1	C	0.37	0/3163	0.63	0/4276
1	D	0.36	0/3163	0.64	0/4276
1	E	0.37	0/3163	0.64	0/4276
1	F	0.37	0/3163	0.64	0/4276
1	G	0.36	0/3163	0.63	0/4276
1	H	0.36	0/3163	0.63	0/4276
All	All	0.37	0/25304	0.63	0/34208

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	3097	0	3076	78	0
1	B	3097	0	3076	72	0
1	C	3097	0	3076	76	0
1	D	3097	0	3076	73	0
1	E	3097	0	3076	79	0

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Mol	Chain	Non-H	H(model)	H(added)	Clashes	Symm-Clashes
1	F	3097	0	3076	74	0
1	G	3097	0	3076	73	0
1	H	3097	0	3076	75	0
2	A	9	0	3	0	0
2	B	9	0	4	1	0
2	C	9	0	4	1	0
2	D	9	0	3	0	0
2	E	9	0	3	1	0
2	F	9	0	3	0	0
2	G	9	0	3	0	0
2	H	9	0	3	0	0
3	A	1	0	0	0	0
3	B	1	0	0	0	0
3	C	1	0	0	0	0
3	D	1	0	0	0	0
3	E	1	0	0	0	0
3	F	1	0	0	0	0
3	G	1	0	0	0	0
3	H	1	0	0	0	0
4	A	79	0	0	3	0
4	B	50	0	0	1	0
4	C	51	0	0	1	0
4	D	64	0	0	0	0
4	E	69	0	0	3	0
4	F	74	0	0	1	0
4	G	65	0	0	1	0
4	H	54	0	0	1	0
All	All	25362	0	24634	559	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 11.

The worst 5 of 559 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:E:266:ASN:HD21	1:E:295:GLY:HA3	1.17	1.10
1:G:266:ASN:HD21	1:G:295:GLY:HA3	1.17	1.09
1:D:266:ASN:HD21	1:D:295:GLY:HA3	1.17	1.08
1:C:266:ASN:HD21	1:C:295:GLY:HA3	1.16	1.05
1:B:266:ASN:HD21	1:B:295:GLY:HA3	1.16	1.04

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	385/391 (98%)	374 (97%)	9 (2%)	2 (0%)	29	31
1	B	385/391 (98%)	374 (97%)	9 (2%)	2 (0%)	29	31
1	C	385/391 (98%)	373 (97%)	10 (3%)	2 (0%)	29	31
1	D	385/391 (98%)	373 (97%)	10 (3%)	2 (0%)	29	31
1	E	385/391 (98%)	372 (97%)	11 (3%)	2 (0%)	29	31
1	F	385/391 (98%)	373 (97%)	11 (3%)	1 (0%)	41	46
1	G	385/391 (98%)	373 (97%)	10 (3%)	2 (0%)	29	31
1	H	385/391 (98%)	371 (96%)	13 (3%)	1 (0%)	41	46
All	All	3080/3128 (98%)	2983 (97%)	83 (3%)	14 (0%)	29	31

5 of 14 Ramachandran outliers are listed below:

Mol	Chain	Res	Type
1	A	42	ASP
1	B	42	ASP
1	C	42	ASP
1	D	42	ASP
1	E	42	ASP

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	341/345 (99%)	328 (96%)	13 (4%)	33	42
1	B	341/345 (99%)	328 (96%)	13 (4%)	33	42
1	C	341/345 (99%)	328 (96%)	13 (4%)	33	42
1	D	341/345 (99%)	328 (96%)	13 (4%)	33	42
1	E	341/345 (99%)	328 (96%)	13 (4%)	33	42
1	F	341/345 (99%)	328 (96%)	13 (4%)	33	42
1	G	341/345 (99%)	328 (96%)	13 (4%)	33	42
1	H	341/345 (99%)	328 (96%)	13 (4%)	33	42
All	All	2728/2760 (99%)	2624 (96%)	104 (4%)	33	42

5 of 104 residues with a non-rotameric sidechain are listed below:

Mol	Chain	Res	Type
1	E	141	GLU
1	F	190	LYS
1	H	239	THR
1	E	237	LEU
1	F	1	MET

Sometimes sidechains can be flipped to improve hydrogen bonding and reduce clashes. 5 of 118 such sidechains are listed below:

Mol	Chain	Res	Type
1	D	380	HIS
1	H	196	HIS
1	E	376	ASN
1	H	152	GLN
1	G	309	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](#)

Of 16 ligands modelled in this entry, 8 are monoatomic - leaving 8 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	LMR	C	392	3	8,8,8	1.31	0	10,10,10	2.17	3 (30%)
2	LMR	G	392	3	8,8,8	1.15	0	10,10,10	2.04	2 (20%)
2	LMR	B	392	3	8,8,8	1.32	0	10,10,10	2.14	2 (20%)
2	LMR	A	392	3	8,8,8	1.20	0	10,10,10	1.97	2 (20%)
2	LMR	D	392	3	8,8,8	1.21	0	10,10,10	2.11	3 (30%)
2	LMR	F	392	3	8,8,8	1.21	0	10,10,10	2.07	3 (30%)
2	LMR	E	392	3	8,8,8	1.23	0	10,10,10	2.11	2 (20%)
2	LMR	H	392	3	8,8,8	1.27	1 (12%)	10,10,10	2.07	2 (20%)

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	LMR	C	392	3	-	2/8/8/8	-
2	LMR	G	392	3	-	3/8/8/8	-
2	LMR	B	392	3	-	2/8/8/8	-
2	LMR	A	392	3	-	3/8/8/8	-
2	LMR	D	392	3	-	4/8/8/8	-
2	LMR	F	392	3	-	3/8/8/8	-
2	LMR	E	392	3	-	2/8/8/8	-
2	LMR	H	392	3	-	2/8/8/8	-

All (1) bond length outliers are listed below:

Mol	Chain	Res	Type	Atoms	Z	Observed(Å)	Ideal(Å)
2	H	392	LMR	O4B-C4	2.02	1.28	1.22

The worst 5 of 19 bond angle outliers are listed below:

Mol	Chain	Res	Type	Atoms	Z	Observed(°)	Ideal(°)
2	C	392	LMR	O1B-C1-C2	4.87	123.03	112.74
2	B	392	LMR	O1B-C1-C2	4.80	122.89	112.74
2	E	392	LMR	O1B-C1-C2	4.75	122.78	112.74
2	H	392	LMR	O1B-C1-C2	4.71	122.70	112.74
2	G	392	LMR	O1B-C1-C2	4.58	122.43	112.74

There are no chirality outliers.

5 of 21 torsion outliers are listed below:

Mol	Chain	Res	Type	Atoms
2	D	392	LMR	O1A-C1-C2-O2
2	D	392	LMR	O1A-C1-C2-C3
2	D	392	LMR	O1B-C1-C2-C3
2	A	392	LMR	O1A-C1-C2-O2
2	A	392	LMR	O1B-C1-C2-O2

There are no ring outliers.

3 monomers are involved in 3 short contacts:

Mol	Chain	Res	Type	Clashes	Symm-Clashes
2	C	392	LMR	1	0
2	B	392	LMR	1	0
2	E	392	LMR	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, 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	387/391 (98%)	-0.31	1 (0%) 94 93	28, 42, 54, 67	0
1	B	387/391 (98%)	-0.32	0 100 100	30, 43, 57, 71	0
1	C	387/391 (98%)	-0.28	0 100 100	31, 44, 59, 71	0
1	D	387/391 (98%)	-0.29	0 100 100	30, 42, 54, 62	0
1	E	387/391 (98%)	-0.28	0 100 100	29, 43, 57, 70	0
1	F	387/391 (98%)	-0.29	0 100 100	28, 41, 53, 64	0
1	G	387/391 (98%)	-0.30	0 100 100	30, 42, 54, 67	0
1	H	387/391 (98%)	-0.25	1 (0%) 94 93	31, 44, 58, 68	0
All	All	3096/3128 (98%)	-0.29	2 (0%) 95 95	28, 43, 57, 71	0

All (2) RSRZ outliers are listed below:

Mol	Chain	Res	Type	RSRZ
1	H	376	ASN	2.2
1	A	1	MET	2.2

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, 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	LMR	C	392	9/9	0.90	0.13	51,54,56,57	0
2	LMR	G	392	9/9	0.90	0.14	41,45,47,47	0
2	LMR	B	392	9/9	0.91	0.10	44,46,52,53	0
2	LMR	E	392	9/9	0.92	0.11	47,50,52,53	0
2	LMR	H	392	9/9	0.92	0.11	55,56,57,57	0
2	LMR	D	392	9/9	0.93	0.12	42,43,44,45	0
2	LMR	F	392	9/9	0.93	0.13	40,42,45,46	0
2	LMR	A	392	9/9	0.94	0.10	34,38,39,41	0
3	MG	E	393	1/1	0.97	0.15	20,20,20,20	0
3	MG	C	393	1/1	0.98	0.10	24,24,24,24	0
3	MG	B	393	1/1	0.98	0.10	20,20,20,20	0
3	MG	F	393	1/1	0.98	0.17	18,18,18,18	0
3	MG	A	393	1/1	0.99	0.13	19,19,19,19	0
3	MG	D	393	1/1	0.99	0.11	18,18,18,18	0
3	MG	G	393	1/1	0.99	0.13	22,22,22,22	0
3	MG	H	393	1/1	0.99	0.16	25,25,25,25	0

6.5 Other polymers [i](#)

There are no such residues in this entry.