wwPDB X-ray Structure Validation Summary Report (i)

Oct 17, 2021 – 08:13 AM EDT

PDB ID	:	1MMX
Title	:	Crystal structure of galactose mutarotase from Lactococcus lactis complexed with D-fucose
Authors	:	Thoden, J.B.; Kim, J.; Raushel, F.M.; Holden, H.M.
Deposited on	:	2002-09-04
Resolution	:	1.80 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 (i) symbol.

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

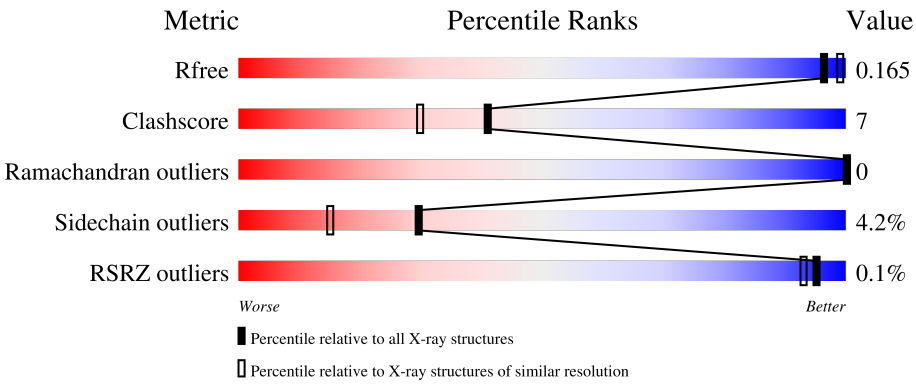
MolProbity	:	4.02b-467
Mogul	:	1.8.5 (274361), CSD as541be (2020)
Xtriage (Phenix)	:	1.13
EDS	:	2.23.2
Percentile statistics	:	20191225.v01 (using entries in the PDB archive December 25th 2019)
Refmac	:	5.8.0158
CCP4	:	7.0.044 (Gargrove)
Ideal geometry (proteins)	:	Engh & Huber (2001)
Ideal geometry (DNA, RNA)	:	Parkinson et al. (1996)
Validation Pipeline (wwPDB-VP)	:	2.23.2

1 Overall quality at a glance (i)

The following experimental techniques were used to determine the structure:
X-RAY DIFFRACTION

The reported resolution of this entry is 1.80 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	5950 (1.80-1.80)
Clashscore	141614	6793 (1.80-1.80)
Ramachandran outliers	138981	6697 (1.80-1.80)
Sidechain outliers	138945	6696 (1.80-1.80)
RSRZ outliers	127900	5850 (1.80-1.80)

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 <=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	347	71% 22% 5% •
1	B	347	76% 20% •

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
2	FUC	A	348[A]	X	-	-	-
2	FUC	A	348[B]	X	-	-	-
2	FUC	B	348[A]	X	-	-	-
2	FUC	B	348[B]	X	-	-	-

2 Entry composition (i)

There are 4 unique types of molecules in this entry. The entry contains 5937 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.

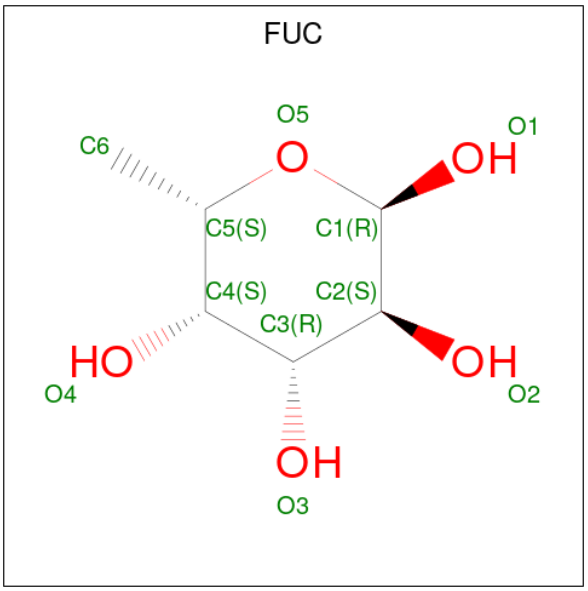
- Molecule 1 is a protein called Aldose 1-epimerase.

Mol	Chain	Residues	Atoms					ZeroOcc	AltConf	Trace
			Total	C	N	O	S			
1	A	339	2666	1683	449	531	3	0	5	0
1	B	346	2740	1726	467	543	4	0	5	0

There are 18 discrepancies between the modelled and reference sequences:

Chain	Residue	Modelled	Actual	Comment	Reference
A	2	SER	GLU	engineered mutation	UNP Q9ZB17
A	340	LEU	-	expression tag	UNP Q9ZB17
A	341	GLU	-	expression tag	UNP Q9ZB17
A	342	HIS	-	expression tag	UNP Q9ZB17
A	343	HIS	-	expression tag	UNP Q9ZB17
A	344	HIS	-	expression tag	UNP Q9ZB17
A	345	HIS	-	expression tag	UNP Q9ZB17
A	346	HIS	-	expression tag	UNP Q9ZB17
A	347	HIS	-	expression tag	UNP Q9ZB17
B	2	SER	GLU	engineered mutation	UNP Q9ZB17
B	340	LEU	-	expression tag	UNP Q9ZB17
B	341	GLU	-	expression tag	UNP Q9ZB17
B	342	HIS	-	expression tag	UNP Q9ZB17
B	343	HIS	-	expression tag	UNP Q9ZB17
B	344	HIS	-	expression tag	UNP Q9ZB17
B	345	HIS	-	expression tag	UNP Q9ZB17
B	346	HIS	-	expression tag	UNP Q9ZB17
B	347	HIS	-	expression tag	UNP Q9ZB17

- Molecule 2 is alpha-L-fucopyranose (three-letter code: FUC) (formula: $C_6H_{12}O_5$).



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

- Molecule 3 is SODIUM ION (three-letter code: NA) (formula: Na).

Mol	Chain	Residues	Atoms		ZeroOcc	AltConf
			Total	Na		
3	A	1	1	1	0	0

- Molecule 4 is water.

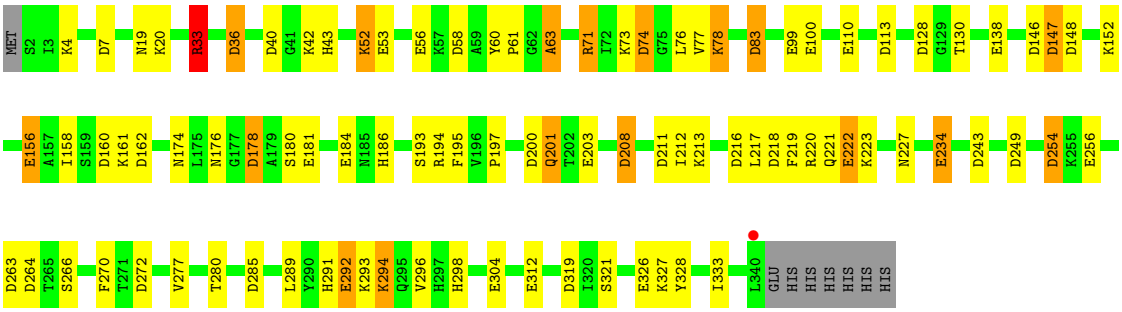
Mol	Chain	Residues	Atoms		ZeroOcc	AltConf
			Total	O		
4	A	234	234	234	0	0
			Total	O		
4	B	272	272	272	0	0

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.

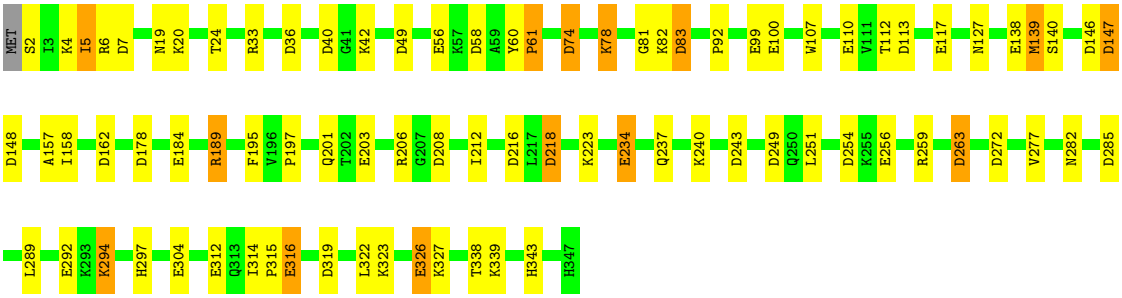
- Molecule 1: Aldose 1-epimerase

Chain A:



- Molecule 1: Aldose 1-epimerase

Chain B:



4 Data and refinement statistics (i)

Property	Value	Source
Space group	P 21 21 21	Depositor
Cell constants a, b, c, α, β, γ	44.90Å 76.30Å 210.90Å 90.00° 90.00° 90.00°	Depositor
Resolution (Å)	30.00 – 1.80 76.30 – 1.71	Depositor EDS
% Data completeness (in resolution range)	97.5 (30.00-1.80) 93.3 (76.30-1.71)	Depositor EDS
R_{merge}	(Not available)	Depositor
R_{sym}	0.05	Depositor
$< I/\sigma(I) >$ [1]	0.36 (at 1.71Å)	Xtriage
Refinement program	TNT	Depositor
R, R_{free}	0.168 , 0.229 0.165 , 0.165	Depositor DCC
R_{free} test set	7403 reflections (10.03%)	wwPDB-VP
Wilson B-factor (Å^2)	14.8	Xtriage
Anisotropy	0.470	Xtriage
Bulk solvent k_{sol}(e/Å^3), B_{sol}(Å^2)	0.30 , 92.4	EDS
L-test for twinning[2]	$< \|L\| > = 0.48$, $< L^2 > = 0.31$	Xtriage
Estimated twinning fraction	No twinning to report.	Xtriage
F_o,F_c correlation	0.97	EDS
Total number of atoms	5937	wwPDB-VP
Average B, all atoms (Å^2)	26.0	wwPDB-VP

Xtriage's analysis on translational NCS is as follows: *The largest off-origin peak in the Patterson function is 4.62% of the height of the origin peak. No significant pseudotranslation is detected.*

[1] Intensities estimated from amplitudes.

[2] Theoretical values of $< |L| >$, $< L^2 >$ 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: FUC, NA

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	0.94	16/2738 (0.6%)	1.40	54/3703 (1.5%)
1	B	0.96	16/2818 (0.6%)	1.37	46/3811 (1.2%)
All	All	0.95	32/5556 (0.6%)	1.38	100/7514 (1.3%)

The worst 5 of 32 bond length outliers are listed below:

Mol	Chain	Res	Type	Atoms	Z	Observed(Å)	Ideal(Å)
1	A	100	GLU	CD-OE2	7.85	1.34	1.25
1	A	99	GLU	CD-OE2	6.54	1.32	1.25
1	A	326	GLU	CD-OE2	6.34	1.32	1.25
1	B	99	GLU	CD-OE2	6.28	1.32	1.25
1	B	203	GLU	CD-OE2	6.24	1.32	1.25

The worst 5 of 100 bond angle outliers are listed below:

Mol	Chain	Res	Type	Atoms	Z	Observed(^{o})	Ideal(^{o})
1	A	71	ARG	NE-CZ-NH2	-9.76	115.42	120.30
1	B	6	ARG	NE-CZ-NH1	9.49	125.05	120.30
1	B	147	ASP	CB-CG-OD2	-9.11	110.10	118.30
1	B	249	ASP	CB-CG-OD2	-8.80	110.38	118.30
1	A	147	ASP	CB-CG-OD2	-8.57	110.59	118.30

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	2666	0	2608	40	0
1	B	2740	0	2652	37	0
2	A	12	0	4	0	0
2	B	12	0	4	0	0
3	A	1	0	0	0	0
4	A	234	0	0	6	0
4	B	272	0	0	4	0
All	All	5937	0	5268	76	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 7.

The worst 5 of 76 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:B:189:ARG:HH11	1:B:189:ARG:HG2	1.24	1.01
1:B:78[B]:LYS:HE2	1:B:81:GLY:HA2	1.50	0.93
1:B:78[B]:LYS:HE2	1:B:81:GLY:CA	2.09	0.82
1:A:201:GLN:NE2	1:A:201:GLN:H	1.78	0.82
1:B:237:GLN:HG2	4:B:566:HOH:O	1.86	0.76

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	342/347 (99%)	321 (94%)	21 (6%)	0	100	100
1	B	349/347 (101%)	332 (95%)	17 (5%)	0	100	100
All	All	691/694 (100%)	653 (94%)	38 (6%)	0	100	100

There are no Ramachandran outliers to report.

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	297/300 (99%)	286 (96%)	11 (4%)	34 19
1	B	304/300 (101%)	288 (95%)	16 (5%)	22 9
All	All	601/600 (100%)	574 (96%)	27 (4%)	30 13

5 of 27 residues with a non-rotameric sidechain are listed below:

Mol	Chain	Res	Type
1	B	78[A]	LYS
1	B	139[A]	MET
1	B	240	LYS
1	B	82	LYS
1	B	139[B]	MET

Sometimes sidechains can be flipped to improve hydrogen bonding and reduce clashes. 5 of 7 such sidechains are listed below:

Mol	Chain	Res	Type
1	B	38	GLN
1	B	88	GLN
1	B	344	HIS
1	B	224	GLN
1	A	227	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 monosaccharides in this entry.

5.6 Ligand geometry (i)

Of 5 ligands modelled in this entry, 1 is monoatomic - leaving 4 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	FUC	A	348[A]	-	11,11,11	0.48	0	15,16,16	1.11	1 (6%)
2	FUC	B	348[B]	-	11,11,11	0.62	0	15,16,16	1.29	2 (13%)
2	FUC	B	348[A]	-	11,11,11	0.68	0	15,16,16	1.29	2 (13%)
2	FUC	A	348[B]	-	11,11,11	0.49	0	15,16,16	1.11	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
2	FUC	A	348[A]	-	5/5/5/5	-	0/1/1/1
2	FUC	B	348[B]	-	5/5/5/5	-	0/1/1/1
2	FUC	B	348[A]	-	5/5/5/5	-	0/1/1/1
2	FUC	A	348[B]	-	5/5/5/5	-	0/1/1/1

There are no bond length outliers.

The worst 5 of 6 bond angle outliers are listed below:

Mol	Chain	Res	Type	Atoms	Z	Observed(^{o})	Ideal(^{o})
2	B	348[A]	FUC	C4-C3-C2	-2.66	106.19	110.82
2	B	348[B]	FUC	C4-C3-C2	-2.66	106.19	110.82
2	A	348[A]	FUC	O2-C2-C1	2.20	114.25	109.16
2	A	348[B]	FUC	O2-C2-C1	2.20	114.25	109.16

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Mol	Chain	Res	Type	Atoms	Z	Observed(^{o})	Ideal(^{o})
2	B	348[A]	FUC	C3-C4-C5	-2.07	106.54	109.77

5 of 20 chirality outliers are listed below:

Mol	Chain	Res	Type	Atom
2	A	348[A]	FUC	C2
2	A	348[A]	FUC	C1
2	A	348[A]	FUC	C5
2	A	348[A]	FUC	C3
2	A	348[A]	FUC	C4

There are no torsion outliers.

There are no ring outliers.

No monomer is involved in short contacts.

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	339/347 (97%)	-0.87	1 (0%) 94 92	12, 23, 54, 92	0
1	B	346/347 (99%)	-0.94	0 100 100	12, 20, 44, 60	0
All	All	685/694 (98%)	-0.91	1 (0%) 95 93	12, 21, 52, 92	0

All (1) RSRZ outliers are listed below:

Mol	Chain	Res	Type	RSRZ
1	A	340	LEU	2.9

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	FUC	B	348[A]	11/11	0.97	0.06	7,18,22,26	1
2	FUC	B	348[B]	11/11	0.97	0.06	15,19,24,26	1
3	NA	A	349	1/1	0.97	0.23	28,28,28,28	0
2	FUC	A	348[B]	11/11	0.98	0.05	11,17,22,26	1

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Mol	Type	Chain	Res	Atoms	RSCC	RSR	B-factors(Å^2)	Q<0.9
2	FUC	A	348[A]	11/11	0.98	0.05	11,18,22,26	1

6.5 Other polymers (i)

There are no such residues in this entry.