



Full wwPDB X-ray Structure Validation Report ⓘ

Mar 5, 2026 – 06:50 PM UTC

PDB ID : 2CZ3 / pdb_00002cz3
Title : Crystal structure of glutathione transferase zeta 1-1 (maleylacetoacetate isomerase) from *Mus musculus* (form-2 crystal)
Authors : Mizohata, E.; Morita, S.; Kinoshita, Y.; Nagano, K.; Uda, H.; Uchikubo, T.; Shirouzu, M.; Yokoyama, S.; RIKEN Structural Genomics/Proteomics Initiative (RSGI)
Deposited on : 2005-07-10
Resolution : 2.30 Å(reported)

This is a Full wwPDB X-ray Structure Validation 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	:	4-5-2 with Phenix2.0
Mogul	:	2022.3.0, CSD as543be (2022)
Xtriage (Phenix)	:	2.0
EDS	:	3.0
Percentile statistics	:	20250101.v01 (using entries in the PDB archive January 1st 2025)
CCP4	:	9.0.010 (Gargrove)
Density-Fitness	:	1.0.12
Ideal geometry (proteins)	:	Engh & Huber (2001)
Ideal geometry (DNA, RNA)	:	Parkinson et al. (1996)
Validation Pipeline (wwPDB-VP)	:	2.49

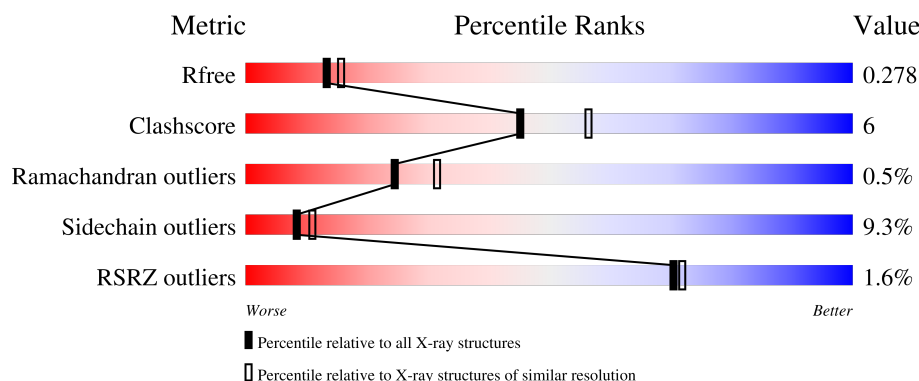
1 Overall quality at a glance

The following experimental techniques were used to determine the structure:

X-RAY DIFFRACTION

The reported resolution of this entry is 2.30 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}	180053	6319 (2.30-2.30)
Clashscore	190562	6919 (2.30-2.30)
Ramachandran outliers	187476	6854 (2.30-2.30)
Sidechain outliers	187428	6854 (2.30-2.30)
RSRZ outliers	180081	6325 (2.30-2.30)

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	223	2% 67% 15% • 14%
1	B	223	% 73% 16% 11%

2 Entry composition

There are 2 unique types of molecules in this entry. The entry contains 3147 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 Maleylacetoacetate isomerase.

Mol	Chain	Residues	Atoms						ZeroOcc	AltConf	Trace
1	A	191	Total	C	N	O	S	Se	0	0	0
			1504	963	260	274	3	4			
1	B	198	Total	C	N	O	S	Se	0	0	0
			1570	1003	270	289	3	5			

There are 26 discrepancies between the modelled and reference sequences:

Chain	Residue	Modelled	Actual	Comment	Reference
A	-6	GLY	-	cloning artifact	UNP Q9WVL0
A	-5	SER	-	cloning artifact	UNP Q9WVL0
A	-4	SER	-	cloning artifact	UNP Q9WVL0
A	-3	GLY	-	cloning artifact	UNP Q9WVL0
A	-2	SER	-	cloning artifact	UNP Q9WVL0
A	-1	SER	-	cloning artifact	UNP Q9WVL0
A	0	GLY	-	cloning artifact	UNP Q9WVL0
A	1	MSE	MET	modified residue	UNP Q9WVL0
A	56	MSE	MET	modified residue	UNP Q9WVL0
A	76	MSE	MET	modified residue	UNP Q9WVL0
A	101	MSE	MET	modified residue	UNP Q9WVL0
A	128	MSE	MET	modified residue	UNP Q9WVL0
A	161	MSE	MET	modified residue	UNP Q9WVL0
B	-6	GLY	-	cloning artifact	UNP Q9WVL0
B	-5	SER	-	cloning artifact	UNP Q9WVL0
B	-4	SER	-	cloning artifact	UNP Q9WVL0
B	-3	GLY	-	cloning artifact	UNP Q9WVL0
B	-2	SER	-	cloning artifact	UNP Q9WVL0
B	-1	SER	-	cloning artifact	UNP Q9WVL0
B	0	GLY	-	cloning artifact	UNP Q9WVL0
B	1	MSE	MET	modified residue	UNP Q9WVL0
B	56	MSE	MET	modified residue	UNP Q9WVL0
B	76	MSE	MET	modified residue	UNP Q9WVL0
B	101	MSE	MET	modified residue	UNP Q9WVL0
B	128	MSE	MET	modified residue	UNP Q9WVL0

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Chain	Residue	Modelled	Actual	Comment	Reference
B	161	MSE	MET	modified residue	UNP Q9WVL0

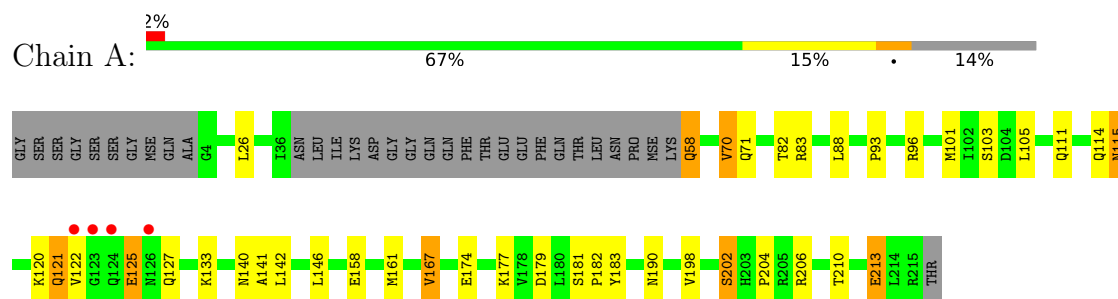
- Molecule 2 is water.

Mol	Chain	Residues	Atoms	ZeroOcc	AltConf
2	A	41	Total O 41 41	0	0
2	B	32	Total O 32 32	0	0

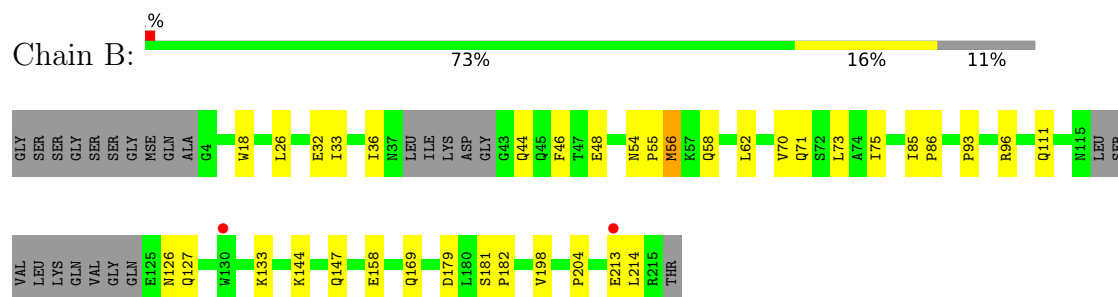
3 Residue-property plots [i](#)

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: Maleylacetoacetate isomerase



- Molecule 1: Maleylacetoacetate isomerase



4 Data and refinement statistics

Property	Value	Source
Space group	P 31 2 1	Depositor
Cell constants a, b, c, α , β , γ	55.81Å 55.81Å 214.41Å 90.00° 90.00° 120.00°	Depositor
Resolution (Å)	70.71 – 2.30 70.71 – 2.30	Depositor EDS
% Data completeness (in resolution range)	96.1 (70.71-2.30) 96.1 (70.71-2.30)	Depositor EDS
R_{merge}	(Not available)	Depositor
R_{sym}	(Not available)	Depositor
$\langle I/\sigma(I) \rangle$ ¹	3.65 (at 2.29Å)	Xtriage
Refinement program	REFMAC 5.1.24	Depositor
R, R_{free}	0.218 , 0.275 0.224 , 0.278	Depositor DCC
R_{free} test set	880 reflections (4.86%)	wwPDB-VP
Wilson B-factor (Å ²)	30.5	Xtriage
Anisotropy	0.303	Xtriage
Bulk solvent k_{sol} (e/Å ³), B_{sol} (Å ²)	0.38 , 37.8	EDS
L-test for twinning ²	$\langle L \rangle = 0.42$, $\langle L^2 \rangle = 0.24$	Xtriage
Estimated twinning fraction	0.085 for -h,-k,l	Xtriage
F_o, F_c correlation	0.92	EDS
Total number of atoms	3147	wwPDB-VP
Average B, all atoms (Å ²)	25.0	wwPDB-VP

Xtriage's analysis on translational NCS is as follows: *The largest off-origin peak in the Patterson function is 6.23% of the height of the origin peak. No significant pseudotranslation is detected.*

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.

5 Model quality [i](#)

5.1 Standard geometry [i](#)

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	0.75	0/1528	0.93	0/2068
1	B	0.77	1/1595 (0.1%)	0.89	0/2155
All	All	0.76	1/3123 (0.0%)	0.91	0/4223

All (1) bond length outliers are listed below:

Mol	Chain	Res	Type	Atoms	Z	Observed(Å)	Ideal(Å)
1	B	56	MSE	SE-CE	-9.60	1.66	1.95

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	1504	0	1560	24	0
1	B	1570	0	1605	19	0
2	A	41	0	0	0	0
2	B	32	0	0	0	0
All	All	3147	0	3165	37	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 6.

All (37) 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:58:GLN:HE21	1:A:58:GLN:N	1.63	0.97
1:A:105:LEU:HD11	1:B:56:MSE:HE1	1.50	0.90
1:A:101:MSE:HE3	1:B:70:VAL:HG22	1.62	0.82
1:A:70:VAL:HG23	1:A:71:GLN:HG2	1.74	0.67
1:B:70:VAL:O	1:B:71:GLN:HB2	2.00	0.61
1:A:58:GLN:N	1:A:58:GLN:NE2	2.45	0.60
1:A:198:VAL:O	1:A:202:SER:OG	2.21	0.59
1:A:142:LEU:O	1:A:146:LEU:HG	2.03	0.58
1:A:105:LEU:HD11	1:B:56:MSE:CE	2.29	0.57
1:A:111:GLN:HE22	1:A:115:ASN:ND2	2.05	0.55
1:B:62:LEU:HD22	1:B:75:ILE:HG23	1.90	0.54
1:A:167:VAL:HG22	1:A:190:ASN:HD22	1.74	0.52
1:A:141:ALA:HB1	1:B:56:MSE:CE	2.39	0.52
1:A:181:SER:N	1:A:182:PRO:CD	2.72	0.52
1:A:167:VAL:HG22	1:A:190:ASN:ND2	2.25	0.51
1:B:85:ILE:HG23	1:B:86:PRO:HA	1.94	0.49
1:B:18:TRP:CD2	1:B:204:PRO:HD3	2.48	0.49
1:B:18:TRP:CE2	1:B:204:PRO:HD3	2.48	0.48
1:B:54:ASN:N	1:B:55:PRO:HD3	2.28	0.48
1:A:26:LEU:HD22	1:A:88:LEU:HD21	1.96	0.46
1:A:103:SER:OG	1:A:161:MSE:HG2	2.16	0.46
1:B:181:SER:N	1:B:182:PRO:CD	2.80	0.45
1:A:82:THR:C	1:A:83:ARG:HD2	2.41	0.45
1:A:141:ALA:CB	1:B:56:MSE:HE3	2.48	0.43
1:B:85:ILE:CG2	1:B:86:PRO:HA	2.48	0.43
1:A:70:VAL:O	1:A:71:GLN:HB2	2.19	0.43
1:B:93:PRO:HA	1:B:96:ARG:HD3	2.01	0.43
1:B:56:MSE:HG2	1:B:58:GLN:HB2	2.00	0.42
1:A:140:ASN:HD22	1:A:183:TYR:HE2	1.67	0.41
1:A:101:MSE:HG2	1:B:70:VAL:O	2.21	0.41
1:B:111:GLN:HG2	1:B:169:GLN:HE22	1.85	0.41
1:B:179:ASP:OD2	1:B:182:PRO:HD3	2.20	0.41
1:A:204:PRO:O	1:A:210:THR:OG1	2.39	0.41
1:B:26:LEU:HD13	1:B:198:VAL:HG21	2.03	0.41
1:A:93:PRO:HA	1:A:96:ARG:HD3	2.03	0.41
1:A:213:GLU:O	1:A:213:GLU:HG2	2.20	0.40
1:A:121:GLN:HE21	1:A:121:GLN:HB3	1.60	0.40

There are no symmetry-related clashes.

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	187/223 (84%)	181 (97%)	4 (2%)	2 (1%)	11	13
1	B	192/223 (86%)	187 (97%)	5 (3%)	0	100	100
All	All	379/446 (85%)	368 (97%)	9 (2%)	2 (0%)	24	31

All (2) Ramachandran outliers are listed below:

Mol	Chain	Res	Type
1	A	125	GLU
1	A	122	VAL

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	169/189 (89%)	152 (90%)	17 (10%)	7	9
1	B	176/189 (93%)	161 (92%)	15 (8%)	10	13
All	All	345/378 (91%)	313 (91%)	32 (9%)	8	11

All (32) residues with a non-rotameric sidechain are listed below:

Mol	Chain	Res	Type
1	A	58	GLN
1	A	70	VAL
1	A	114	GLN
1	A	115	ASN

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Mol	Chain	Res	Type
1	A	120	LYS
1	A	121	GLN
1	A	125	GLU
1	A	127	GLN
1	A	133	LYS
1	A	158	GLU
1	A	167	VAL
1	A	174	GLU
1	A	177	LYS
1	A	179	ASP
1	A	202	SER
1	A	206	ARG
1	A	213	GLU
1	B	32	GLU
1	B	33	ILE
1	B	36	ILE
1	B	44	GLN
1	B	46	PHE
1	B	48	GLU
1	B	73	LEU
1	B	126	ASN
1	B	127	GLN
1	B	133	LYS
1	B	144	LYS
1	B	147	GLN
1	B	158	GLU
1	B	213	GLU
1	B	214	LEU

Sometimes sidechains can be flipped to improve hydrogen bonding and reduce clashes. All (16) such sidechains are listed below:

Mol	Chain	Res	Type
1	A	114	GLN
1	A	115	ASN
1	A	121	GLN
1	A	129	GLN
1	A	140	ASN
1	A	172	ASN
1	A	190	ASN
1	B	51	GLN
1	B	58	GLN
1	B	71	GLN

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Mol	Chain	Res	Type
1	B	115	ASN
1	B	127	GLN
1	B	129	GLN
1	B	140	ASN
1	B	147	GLN
1	B	190	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 oligosaccharides in this entry.

5.6 Ligand geometry [i](#)

There are no ligands in this entry.

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	187/223 (83%)	0.03	4 (2%) 63 65	15, 23, 50, 61	0
1	B	193/223 (86%)	0.04	2 (1%) 79 80	14, 23, 44, 52	0
All	All	380/446 (85%)	0.04	6 (1%) 70 72	14, 23, 45, 61	0

All (6) RSRZ outliers are listed below:

Mol	Chain	Res	Type	RSRZ
1	A	122	VAL	3.3
1	B	213	GLU	3.0
1	A	123	GLY	2.9
1	B	130	TRP	2.3
1	A	124	GLN	2.3
1	A	126	ASN	2.1

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 oligosaccharides in this entry.

6.4 Ligands [i](#)

There are no ligands in this entry.

6.5 Other polymers [i](#)

There are no such residues in this entry.