



# Full wwPDB X-ray Structure Validation Report ⓘ

Feb 19, 2024 – 05:59 PM EST

PDB ID : 4KDE  
Title : Crystal Structure of the Apo Form of Thermus thermophilus Malate Dehydrogenase  
Authors : Hsu, C.-H.; Hong, C.-H.; Chang, Y.-Y.  
Deposited on : 2013-04-25  
Resolution : 1.80 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](mailto: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  
Xtriage (Phenix) : 1.13  
EDS : 2.36  
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

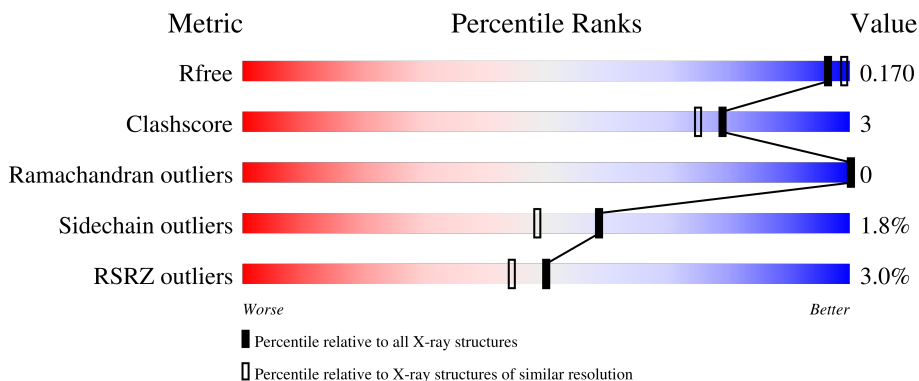
# 1 Overall quality at a glance

The following experimental techniques were used to determine the structure:

*X-RAY DIFFRACTION*

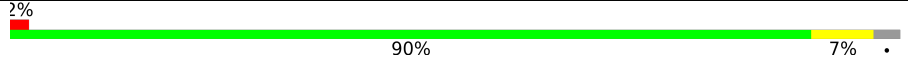
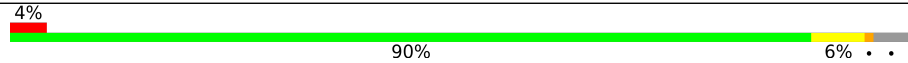
The reported resolution of this entry is 1.80 Å.

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  $\geq 3$ , 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	341	 2% 90% 7% .
1	B	341	 4% 90% 6% . .

## 2 Entry composition i

There are 2 unique types of molecules in this entry. The entry contains 5875 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 Malate dehydrogenase.

Mol	Chain	Residues	Atoms					ZeroOcc	AltConf	Trace
			Total	C	N	O	S			
1	A	331	2521	1597	445	466	13	0	0	0
1	B	329	2508	1588	443	464	13	0	0	0

There are 28 discrepancies between the modelled and reference sequences:

Chain	Residue	Modelled	Actual	Comment	Reference
A	328	ARG	-	expression tag	UNP P10584
A	329	LYS	-	expression tag	UNP P10584
A	330	LEU	-	expression tag	UNP P10584
A	331	ALA	-	expression tag	UNP P10584
A	332	ALA	-	expression tag	UNP P10584
A	333	ALA	-	expression tag	UNP P10584
A	334	LEU	-	expression tag	UNP P10584
A	335	GLU	-	expression tag	UNP P10584
A	336	HIS	-	expression tag	UNP P10584
A	337	HIS	-	expression tag	UNP P10584
A	338	HIS	-	expression tag	UNP P10584
A	339	HIS	-	expression tag	UNP P10584
A	340	HIS	-	expression tag	UNP P10584
A	341	HIS	-	expression tag	UNP P10584
B	328	ARG	-	expression tag	UNP P10584
B	329	LYS	-	expression tag	UNP P10584
B	330	LEU	-	expression tag	UNP P10584
B	331	ALA	-	expression tag	UNP P10584
B	332	ALA	-	expression tag	UNP P10584
B	333	ALA	-	expression tag	UNP P10584
B	334	LEU	-	expression tag	UNP P10584
B	335	GLU	-	expression tag	UNP P10584
B	336	HIS	-	expression tag	UNP P10584
B	337	HIS	-	expression tag	UNP P10584
B	338	HIS	-	expression tag	UNP P10584

*Continued on next page...*

*Continued from previous page...*

Chain	Residue	Modelled	Actual	Comment	Reference
B	339	HIS	-	expression tag	UNP P10584
B	340	HIS	-	expression tag	UNP P10584
B	341	HIS	-	expression tag	UNP P10584

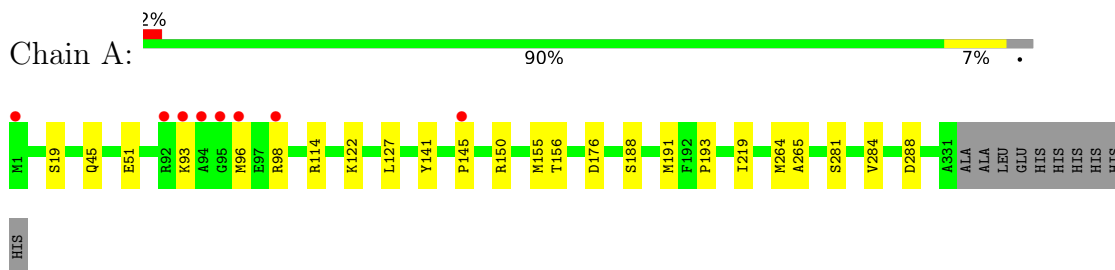
- Molecule 2 is water.

Mol	Chain	Residues	Atoms		ZeroOcc	AltConf
2	A	449	Total 449	O 449	0	0
2	B	397	Total 397	O 397	0	0

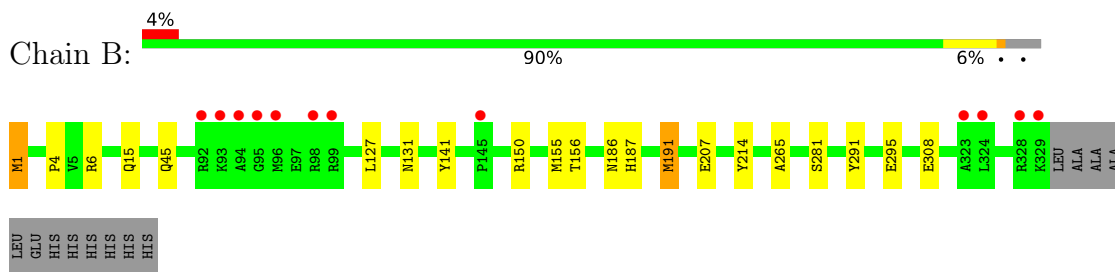
### 3 Residue-property plots [i](#)

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: Malate dehydrogenase



- Molecule 1: Malate dehydrogenase



## 4 Data and refinement statistics

Property	Value	Source
Space group	P 21 21 21	Depositor
Cell constants a, b, c, $\alpha$ , $\beta$ , $\gamma$	71.17Å 86.01Å 118.12Å 90.00° 90.00° 90.00°	Depositor
Resolution (Å)	27.86 – 1.80 27.86 – 1.80	Depositor EDS
% Data completeness (in resolution range)	99.9 (27.86-1.80) 97.9 (27.86-1.80)	Depositor EDS
$R_{merge}$	0.06	Depositor
$R_{sym}$	0.06	Depositor
$\langle I/\sigma(I) \rangle$ <sup>1</sup>	0.64 (at 1.79Å)	Xtrriage
Refinement program	PHENIX (phenix.refine: 1.8.2_1309)	Depositor
R, $R_{free}$	0.144 , 0.170 0.144 , 0.170	Depositor DCC
$R_{free}$ test set	2000 reflections (2.94%)	wwPDB-VP
Wilson B-factor (Å <sup>2</sup> )	14.6	Xtrriage
Anisotropy	0.047	Xtrriage
Bulk solvent $k_{sol}$ (e/Å <sup>3</sup> ), $B_{sol}$ (Å <sup>2</sup> )	0.35 , 50.7	EDS
L-test for twinning <sup>2</sup>	$\langle  L  \rangle = 0.49$ , $\langle L^2 \rangle = 0.32$	Xtrriage
Estimated twinning fraction	No twinning to report.	Xtrriage
$F_o, F_c$ correlation	0.97	EDS
Total number of atoms	5875	wwPDB-VP
Average B, all atoms (Å <sup>2</sup> )	20.0	wwPDB-VP

Xtrriage's analysis on translational NCS is as follows: *The largest off-origin peak in the Patterson function is 4.16% 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](#)

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	0.35	0/2565	0.52	0/3472
1	B	0.34	0/2552	0.51	0/3454
All	All	0.34	0/5117	0.52	0/6926

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	2521	0	2569	14	0
1	B	2508	0	2553	14	0
2	A	449	0	0	6	0
2	B	397	0	0	8	0
All	All	5875	0	5122	28	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 3.

All (28) 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:308:GLU:OE1	2:B:731:HOH:O	1.90	0.90

*Continued on next page...*

Continued from previous page...

Atom-1	Atom-2	Interatomic distance (Å)	Clash overlap (Å)
1:A:288:ASP:OD2	2:A:794:HOH:O	1.97	0.81
1:B:4:PRO:HG3	2:B:689:HOH:O	1.93	0.67
1:A:176:ASP:OD1	2:A:795:HOH:O	2.12	0.66
1:A:19:SER:O	2:A:784:HOH:O	2.15	0.63
1:B:131:ASN:ND2	2:B:736:HOH:O	2.04	0.60
1:A:265:ALA:HA	1:A:281:SER:HA	1.85	0.57
1:A:127:LEU:HD11	1:A:155:MET:HB2	1.90	0.54
1:B:265:ALA:HA	1:B:281:SER:HA	1.90	0.54
1:B:6:ARG:NE	2:B:742:HOH:O	2.14	0.52
1:A:188:SER:O	1:A:191:MET:HG2	2.10	0.50
1:B:127:LEU:HD11	1:B:155:MET:HB2	1.94	0.49
1:A:264:MET:SD	1:A:284:VAL:HG21	2.53	0.49
1:B:1:MET:HE3	1:B:1:MET:HB2	1.86	0.47
1:A:114:ARG:NH2	2:A:800:HOH:O	2.48	0.47
1:B:187:HIS:HD2	2:B:736:HOH:O	1.98	0.47
1:A:145:PRO:HA	2:A:791:HOH:O	2.15	0.46
1:A:156:THR:HG21	1:A:281:SER:HB2	1.99	0.44
1:B:186:ASN:O	1:B:191:MET:HB3	2.18	0.44
1:B:295:GLU:O	2:B:794:HOH:O	2.21	0.43
1:B:150:ARG:HG3	1:B:291:TYR:OH	2.18	0.43
1:A:193:PRO:HG2	1:A:219:ILE:HG12	2.00	0.43
1:B:15:GLN:HG2	2:B:757:HOH:O	2.18	0.42
1:B:207:GLU:OE2	2:B:758:HOH:O	2.21	0.42
1:A:93:LYS:HB3	1:A:96:MET:SD	2.60	0.42
1:B:156:THR:HG21	1:B:281:SER:HB2	2.00	0.42
1:A:122:LYS:HA	1:A:122:LYS:HD3	1.84	0.41
1:A:51:GLU:HG3	2:A:775:HOH:O	2.21	0.41

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	329/341 (96%)	328 (100%)	1 (0%)	0	100	100
1	B	327/341 (96%)	326 (100%)	1 (0%)	0	100	100
All	All	656/682 (96%)	654 (100%)	2 (0%)	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	255/263 (97%)	251 (98%)	4 (2%)	62	54
1	B	254/263 (97%)	249 (98%)	5 (2%)	55	44
All	All	509/526 (97%)	500 (98%)	9 (2%)	59	48

All (9) residues with a non-rotameric sidechain are listed below:

Mol	Chain	Res	Type
1	A	45	GLN
1	A	98	ARG
1	A	141	TYR
1	A	150	ARG
1	B	1	MET
1	B	45	GLN
1	B	141	TYR
1	B	191	MET
1	B	214	TYR

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

### 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](#)

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

### 6.1 Protein, DNA and RNA chains

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	331/341 (97%)	-0.34	8 (2%) 59 54	7, 13, 32, 67	0
1	B	329/341 (96%)	-0.14	12 (3%) 42 37	7, 17, 43, 74	0
All	All	660/682 (96%)	-0.24	20 (3%) 50 44	7, 14, 39, 74	0

All (20) RSRZ outliers are listed below:

Mol	Chain	Res	Type	RSRZ
1	A	94	ALA	5.3
1	B	328	ARG	5.2
1	B	99	ARG	4.7
1	B	94	ALA	4.6
1	A	93	LYS	4.5
1	A	96	MET	4.1
1	B	95	GLY	4.1
1	B	92	ARG	3.8
1	B	93	LYS	3.8
1	B	329	LYS	3.4
1	A	92	ARG	3.1
1	B	96	MET	3.0
1	A	145	PRO	3.0
1	A	98	ARG	2.9
1	B	324	LEU	2.5
1	A	95	GLY	2.5
1	A	1	MET	2.4
1	B	145	PRO	2.3
1	B	98	ARG	2.2
1	B	323	ALA	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 monosaccharides 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.