



# Full wwPDB X-ray Structure Validation Report ⓘ

May 26, 2020 – 10:52 pm BST

PDB ID : 5H8P  
Title : Crystal structure of Mycobacterium tuberculosis malate synthase in apo form  
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Deposited on : 2015-12-23  
Resolution : 2.10 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.

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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
Xtriage (Phenix)	:	1.13
EDS	:	2.11
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)	:	2.11

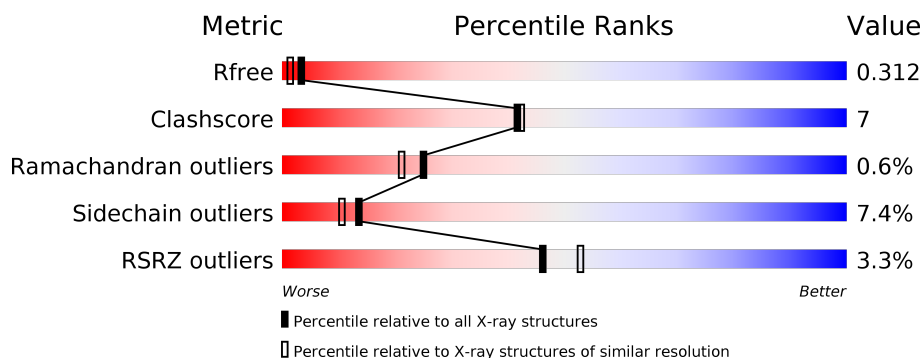
# 1 Overall quality at a glance

The following experimental techniques were used to determine the structure:

## *X-RAY DIFFRACTION*

The reported resolution of this entry is 2.10 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	5197 (2.10-2.10)
Clashscore	141614	5710 (2.10-2.10)
Ramachandran outliers	138981	5647 (2.10-2.10)
Sidechain outliers	138945	5648 (2.10-2.10)
RSRZ outliers	127900	5083 (2.10-2.10)

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 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	741	<div> <div>3%</div> <div> <div></div> <div>76%</div> <div>17%</div> <div>• 5%</div> </div> </div>

## 2 Entry composition

There are 2 unique types of molecules in this entry. The entry contains 5489 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 synthase G.

Mol	Chain	Residues	Atoms					ZeroOcc	AltConf	Trace
1	A	701	Total	C	N	O	S	0	3	0
			5387	3387	950	1027	23			

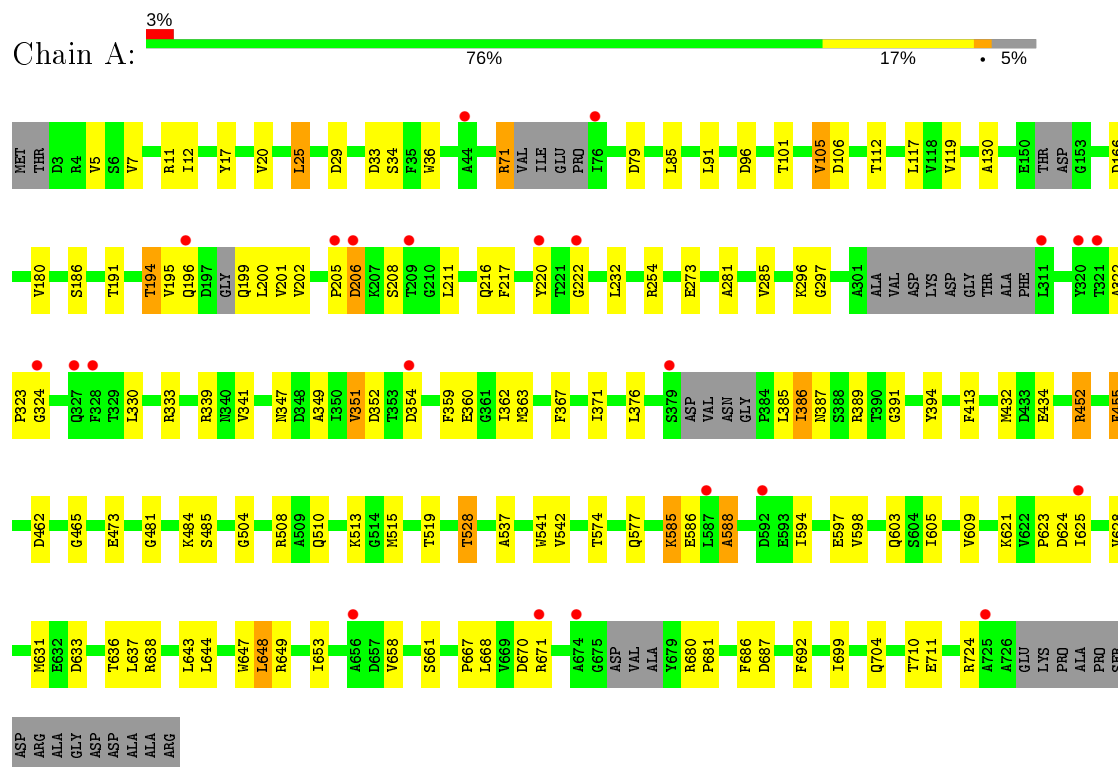
- Molecule 2 is water.

Mol	Chain	Residues	Atoms		ZeroOcc	AltConf
2	A	102	Total	O	0	0
			102	102		

### 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: Malate synthase G



## 4 Data and refinement statistics

Property	Value	Source
Space group	P 43 21 2	Depositor
Cell constants a, b, c, $\alpha$ , $\beta$ , $\gamma$	81.79 Å 81.79 Å 227.08 Å 90.00° 90.00° 90.00°	Depositor
Resolution (Å)	45.96 – 2.10 45.96 – 2.10	Depositor EDS
% Data completeness (in resolution range)	88.2 (45.96-2.10) 88.2 (45.96-2.10)	Depositor EDS
$R_{merge}$	0.11	Depositor
$R_{sym}$	0.06	Depositor
$\langle I/\sigma(I) \rangle$ <sup>1</sup>	3.44 (at 2.10 Å)	Xtriage
Refinement program	PHENIX 1.8.2_1309	Depositor
R, $R_{free}$	0.251 , 0.312 0.251 , 0.312	Depositor DCC
$R_{free}$ test set	2052 reflections (5.09%)	wwPDB-VP
Wilson B-factor (Å <sup>2</sup> )	34.3	Xtriage
Anisotropy	0.433	Xtriage
Bulk solvent $k_{sol}$ (e/Å <sup>3</sup> ), $B_{sol}$ (Å <sup>2</sup> )	0.32 , 33.3	EDS
L-test for twinning <sup>2</sup>	$\langle  L  \rangle = 0.49$ , $\langle L^2 \rangle = 0.33$	Xtriage
Estimated twinning fraction	No twinning to report.	Xtriage
$F_o, F_c$ correlation	0.92	EDS
Total number of atoms	5489	wwPDB-VP
Average B, all atoms (Å <sup>2</sup> )	33.0	wwPDB-VP

Xtriage's analysis on translational NCS is as follows: *The largest off-origin peak in the Patterson function is 4.38% 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	0.41	0/5494	0.58	0/7459

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	5387	0	5351	75	0
2	A	102	0	0	8	0
All	All	5489	0	5351	75	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.

All (75) 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:297:GLY:HA3	1:A:385:LEU:HB2	1.64	0.78
1:A:194:THR:HG23	1:A:201:VAL:HG13	1.71	0.70
1:A:359:PHE:HB2	1:A:362:ILE:HD12	1.76	0.68
1:A:434:GLU:OE1	2:A:801:HOH:O	2.12	0.68

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Atom-1	Atom-2	Interatomic distance (Å)	Clash overlap (Å)
1:A:333:ARG:HH21	1:A:333:ARG:HB2	1.62	0.65
1:A:322:ALA:O	1:A:324:GLY:N	2.27	0.64
1:A:462:ASP:OD2	2:A:802:HOH:O	2.14	0.64
1:A:633:ASP:O	1:A:636:THR:HG22	1.99	0.62
1:A:7:VAL:HG11	1:A:36:TRP:HB3	1.84	0.59
1:A:473:GLU:OE1	1:A:649:ARG:NE	2.34	0.59
1:A:605:ILE:HD13	1:A:699:ILE:HD11	1.85	0.59
1:A:711:GLU:OE2	2:A:803:HOH:O	2.17	0.58
1:A:333:ARG:HE	1:A:385:LEU:HD13	1.69	0.57
1:A:603:GLN:NE2	1:A:623:PRO:O	2.36	0.57
1:A:339:ARG:NH1	1:A:432[B]:MET:SD	2.77	0.57
1:A:341:VAL:HG11	1:A:360:GLU:HG2	1.87	0.56
1:A:413:PHE:CB	1:A:452:ARG:HH11	2.20	0.55
1:A:386:ILE:HD11	1:A:389:ARG:HA	1.90	0.54
1:A:222:GLY:N	2:A:805:HOH:O	2.28	0.53
1:A:658:VAL:HG11	1:A:699:ILE:HG21	1.91	0.53
1:A:117:LEU:HD23	1:A:542:VAL:HG23	1.91	0.53
1:A:200:LEU:HB2	1:A:217:PHE:CD1	2.43	0.53
1:A:609:VAL:HG23	1:A:637:LEU:HD11	1.91	0.52
1:A:594:ILE:O	1:A:598:VAL:HG12	2.08	0.52
1:A:281:ALA:HB2	1:A:349:ALA:HA	1.91	0.52
1:A:413:PHE:HB3	1:A:452:ARG:HH11	1.75	0.51
1:A:455:PHE:CD1	1:A:455:PHE:C	2.85	0.50
1:A:11:ARG:HB2	1:A:351:VAL:HG12	1.93	0.50
1:A:281:ALA:O	1:A:285:VAL:HG23	2.12	0.49
1:A:481:GLY:HA2	1:A:484:LYS:HE3	1.93	0.49
1:A:515:MET:HE1	1:A:541:TRP:HB3	1.95	0.48
1:A:296[B]:LYS:HD2	1:A:296[B]:LYS:HA	1.48	0.48
1:A:367:PHE:O	1:A:371:ILE:HG12	2.13	0.48
1:A:513:LYS:HD2	1:A:537:ALA:HB2	1.96	0.48
1:A:603:GLN:HE21	1:A:624:ASP:HA	1.80	0.47
1:A:206:ASP:OD2	1:A:206:ASP:N	2.48	0.47
1:A:504:GLY:O	1:A:508:ARG:HD2	2.15	0.46
1:A:648:LEU:HD13	1:A:653:ILE:HG13	1.97	0.46
1:A:623:PRO:HA	1:A:628:VAL:O	2.15	0.46
1:A:585:LYS:O	1:A:588:ALA:HB2	2.16	0.46
1:A:597:GLU:HG2	1:A:647:TRP:CH2	2.51	0.46
1:A:637:LEU:HB3	1:A:710:THR:HG21	1.99	0.45
1:A:119:VAL:HG11	1:A:130:ALA:HB2	1.98	0.45
1:A:195:VAL:HG11	1:A:220:TYR:CE2	2.51	0.45
1:A:296[B]:LYS:NZ	2:A:817:HOH:O	2.49	0.45

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Atom-1	Atom-2	Interatomic distance (Å)	Clash overlap (Å)
1:A:455:PHE:HB2	1:A:510:GLN:HB2	1.98	0.44
1:A:465:GLY:HA3	1:A:638:ARG:HG2	1.99	0.44
1:A:191:THR:HA	1:A:254:ARG:O	2.18	0.44
1:A:20:VAL:HG12	1:A:25:LEU:HD22	1.99	0.44
1:A:71:ARG:HA	1:A:71:ARG:HD3	1.86	0.44
1:A:680:ARG:HA	1:A:681:PRO:HD2	1.84	0.43
1:A:106:ASP:OD2	1:A:394:TYR:OH	2.27	0.43
1:A:347:ASN:HB3	1:A:363:MET:HE3	2.01	0.43
1:A:12:ILE:HD13	1:A:36:TRP:CZ3	2.53	0.43
1:A:105:VAL:HG21	2:A:879:HOH:O	2.19	0.43
1:A:333:ARG:HB2	1:A:333:ARG:NH2	2.32	0.43
1:A:574:THR:OG1	1:A:577:GLN:HG3	2.19	0.43
1:A:452:ARG:HD2	2:A:896:HOH:O	2.18	0.42
1:A:5:VAL:HG21	1:A:17:TYR:CD2	2.55	0.42
1:A:648:LEU:HA	1:A:648:LEU:HD12	1.90	0.42
1:A:519:THR:HG21	1:A:621:LYS:NZ	2.35	0.41
1:A:644:LEU:HA	1:A:644:LEU:HD23	1.90	0.41
1:A:386:ILE:HD12	2:A:897:HOH:O	2.21	0.41
1:A:455:PHE:HD1	1:A:455:PHE:C	2.23	0.41
1:A:515:MET:CE	1:A:541:TRP:HB3	2.51	0.41
1:A:637:LEU:HA	1:A:637:LEU:HD12	1.79	0.41
1:A:686:PHE:HB3	1:A:692:PHE:CD2	2.56	0.41
1:A:455:PHE:CB	1:A:510:GLN:HB2	2.51	0.41
1:A:376:LEU:HD22	1:A:391:GLY:HA2	2.03	0.41
1:A:605:ILE:CD1	1:A:699:ILE:HD11	2.48	0.41
1:A:180:VAL:HG11	1:A:232:LEU:HD13	2.04	0.40
1:A:211:LEU:HD13	1:A:216:GLN:HB2	2.02	0.40
1:A:341:VAL:HG11	1:A:360:GLU:CG	2.51	0.40
1:A:667:PRO:O	1:A:670:ASP:HB2	2.21	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	690/741 (93%)	654 (95%)	32 (5%)	4 (1%)	25 21

All (4) Ramachandran outliers are listed below:

Mol	Chain	Res	Type
1	A	588	ALA
1	A	387	ASN
1	A	205	PRO
1	A	323	PRO

### 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	568/594 (96%)	526 (93%)	42 (7%)	13 10

All (42) residues with a non-rotameric sidechain are listed below:

Mol	Chain	Res	Type
1	A	25	LEU
1	A	29	ASP
1	A	33	ASP
1	A	34	SER
1	A	71	ARG
1	A	79	ASP
1	A	85	LEU
1	A	91	LEU
1	A	96	ASP
1	A	101	THR
1	A	105	VAL
1	A	112	THR
1	A	166	ASP
1	A	186	SER
1	A	194	THR
1	A	196	GLN
1	A	199	GLN

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Mol	Chain	Res	Type
1	A	202	VAL
1	A	206	ASP
1	A	208	SER
1	A	273	GLU
1	A	330	LEU
1	A	351	VAL
1	A	352	ASP
1	A	354	ASP
1	A	386	ILE
1	A	452	ARG
1	A	455	PHE
1	A	485	SER
1	A	528	THR
1	A	585	LYS
1	A	586	GLU
1	A	625	ILE
1	A	631	MET
1	A	643	LEU
1	A	648	LEU
1	A	661	SER
1	A	668	LEU
1	A	671	ARG
1	A	687	ASP
1	A	704	GLN
1	A	724	ARG

Some sidechains can be flipped to improve hydrogen bonding and reduce clashes. All (1) such sidechains are listed below:

Mol	Chain	Res	Type
1	A	603	GLN

### 5.3.3 RNA ⓘ

There are no RNA molecules in this entry.

## 5.4 Non-standard residues in protein, DNA, RNA chains ⓘ

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](#)

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	701/741 (94%)	0.39	23 (3%)	46 53	16, 31, 57, 79	0

All (23) RSRZ outliers are listed below:

Mol	Chain	Res	Type	RSRZ
1	A	311	LEU	4.1
1	A	725	ALA	3.8
1	A	674	ALA	3.4
1	A	379	SER	3.3
1	A	209	THR	3.0
1	A	625	ILE	3.0
1	A	324	GLY	2.9
1	A	354	ASP	2.8
1	A	327	GLN	2.5
1	A	220	TYR	2.5
1	A	206	ASP	2.4
1	A	320	TYR	2.4
1	A	321	THR	2.3
1	A	671	ARG	2.3
1	A	587	LEU	2.3
1	A	656	ALA	2.3
1	A	205	PRO	2.2
1	A	222	GLY	2.2
1	A	196	GLN	2.2
1	A	328	PHE	2.2
1	A	592	ASP	2.2
1	A	44	ALA	2.1
1	A	76	ILE	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 carbohydrates 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.