



Full wwPDB X-ray Structure Validation Report ⓘ

Dec 12, 2023 – 06:53 pm GMT

PDB ID : 4APA
Title : Crystal structure of Mycobacterium tuberculosis fumarase (Rv1098c) S318A
in apo form
Authors : Bellinzoni, M.; Haouz, A.; Mechaly, A.E.; Alzari, P.M.
Deposited on : 2012-03-31
Resolution : 2.04 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 : 4.02b-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

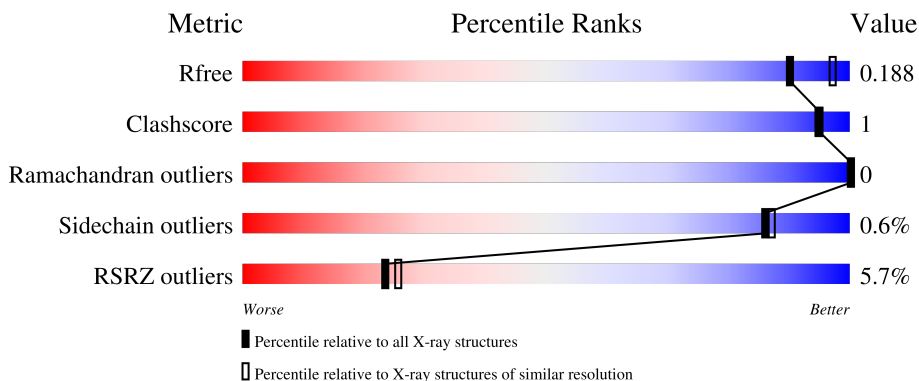
1 Overall quality at a glance

The following experimental techniques were used to determine the structure:

X-RAY DIFFRACTION

The reported resolution of this entry is 2.04 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	1692 (2.04-2.04)
Clashscore	141614	1773 (2.04-2.04)
Ramachandran outliers	138981	1752 (2.04-2.04)
Sidechain outliers	138945	1752 (2.04-2.04)
RSRZ outliers	127900	1672 (2.04-2.04)

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	474	 7% 91% 7%
1	B	474	 8% 91% 5%
1	C	474	 2% 91% 6%
1	D	474	 5% 91% 6%

2 Entry composition [i](#)

There are 2 unique types of molecules in this entry. The entry contains 13702 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 FUMARATE HYDRATASE CLASS II.

Mol	Chain	Residues	Atoms					ZeroOcc	AltConf	Trace
			Total	C	N	O	S			
1	A	440	3175	1976	573	616	10	0	1	0
1	B	449	3278	2046	589	632	11	0	0	0
1	C	445	3244	2025	587	622	10	0	0	0
1	D	444	3207	2003	575	619	10	0	0	0

There are 8 discrepancies between the modelled and reference sequences:

Chain	Residue	Modelled	Actual	Comment	Reference
A	1	GLY	-	expression tag	UNP O53446
A	318	ALA	SER	engineered mutation	UNP O53446
B	1	GLY	-	expression tag	UNP O53446
B	318	ALA	SER	engineered mutation	UNP O53446
C	1	GLY	-	expression tag	UNP O53446
C	318	ALA	SER	engineered mutation	UNP O53446
D	1	GLY	-	expression tag	UNP O53446
D	318	ALA	SER	engineered mutation	UNP O53446

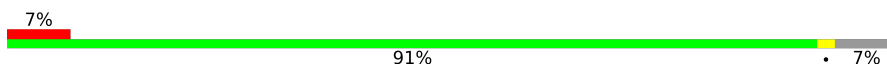
- Molecule 2 is water.

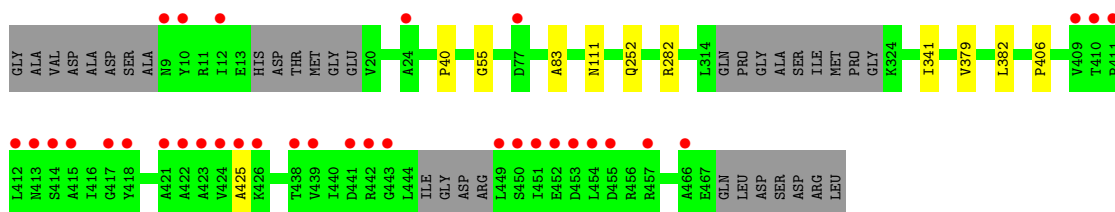
Mol	Chain	Residues	Atoms		ZeroOcc	AltConf
2	A	212	Total 212	O 212	0	0
2	B	156	Total 156	O 156	0	0
2	C	227	Total 227	O 227	0	0
2	D	203	Total 203	O 203	0	0

3 Residue-property plots i

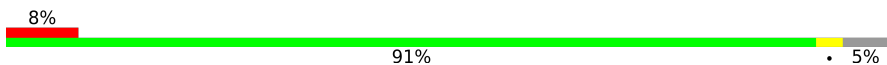
These plots are drawn for all protein, RNA, DNA and oligosaccharide chains in the entry. The first graphic for a chain summarises the proportions of the various outlier classes displayed in the second graphic. The second graphic shows the sequence view annotated by issues in geometry and electron density. 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.

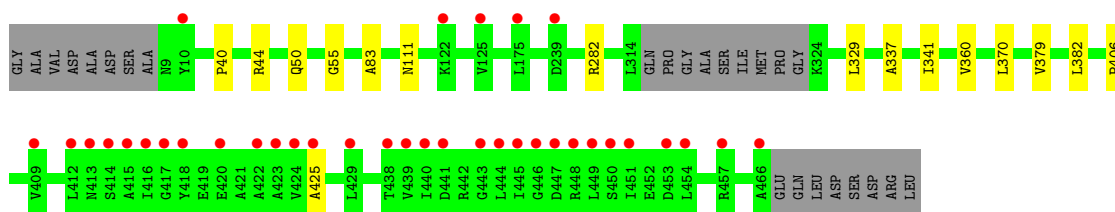
- Molecule 1: FUMARATE HYDRATASE CLASS II

Chain A: 



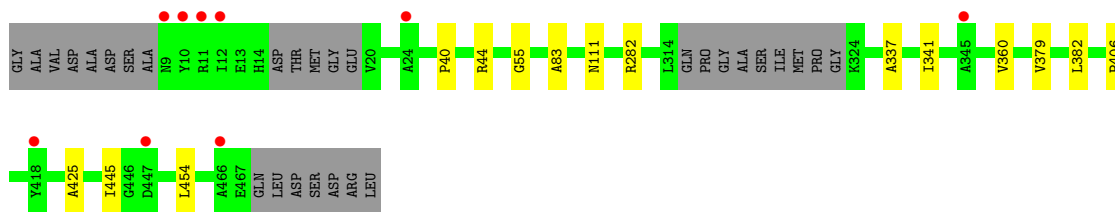
- Molecule 1: FUMARATE HYDRATASE CLASS II

Chain B: 

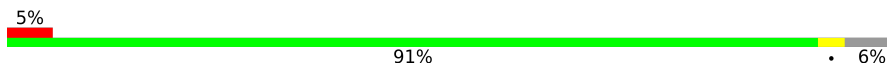


- Molecule 1: FUMARATE HYDRATASE CLASS II

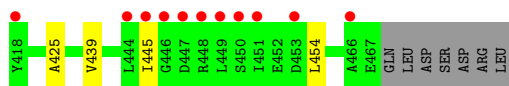
Chain C: 



- Molecule 1: FUMARATE HYDRATASE CLASS II

Chain D: 





4 Data and refinement statistics

Property	Value	Source
Space group	C 1 2 1	Depositor
Cell constants a, b, c, α , β , γ	268.27Å 97.14Å 96.44Å 90.00° 104.54° 90.00°	Depositor
Resolution (Å)	43.41 – 2.04 43.41 – 2.04	Depositor EDS
% Data completeness (in resolution range)	97.2 (43.41-2.04) 97.8 (43.41-2.04)	Depositor EDS
R_{merge}	0.08	Depositor
R_{sym}	(Not available)	Depositor
$\langle I/\sigma(I) \rangle$ ¹	2.10 (at 2.05Å)	Xtrriage
Refinement program	BUSTER 2.11.2	Depositor
R, R_{free}	0.165 , 0.179 0.171 , 0.188	Depositor DCC
R_{free} test set	7424 reflections (5.01%)	wwPDB-VP
Wilson B-factor (Å ²)	25.9	Xtrriage
Anisotropy	0.532	Xtrriage
Bulk solvent k_{sol} (e/Å ³), B_{sol} (Å ²)	0.35 , 45.7	EDS
L-test for twinning ²	$\langle L \rangle = 0.47$, $\langle L^2 \rangle = 0.30$	Xtrriage
Estimated twinning fraction	No twinning to report.	Xtrriage
F_o, F_c correlation	0.96	EDS
Total number of atoms	13702	wwPDB-VP
Average B, all atoms (Å ²)	34.0	wwPDB-VP

Xtrriage's analysis on translational NCS is as follows: *The largest off-origin peak in the Patterson function is 5.96% 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	0.48	0/3219	0.56	0/4389
1	B	0.48	0/3324	0.57	0/4529
1	C	0.49	0/3287	0.56	0/4475
1	D	0.50	0/3250	0.56	0/4431
All	All	0.49	0/13080	0.56	0/17824

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	3175	0	3117	6	0
1	B	3278	0	3265	11	0
1	C	3244	0	3242	10	0
1	D	3207	0	3174	9	0
2	A	212	0	0	1	0
2	B	156	0	0	1	0
2	C	227	0	0	2	0
2	D	203	0	0	0	0
All	All	13702	0	12798	31	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 1.

All (31) 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:40:PRO:HD2	1:C:382:LEU:HD11	1.86	0.57
1:C:445:ILE:HD11	1:C:454:LEU:HD22	1.88	0.56
1:B:50:GLN:HG2	1:B:370:LEU:CD1	2.36	0.55
1:D:445:ILE:HD11	1:D:454:LEU:HD22	1.89	0.55
1:B:382:LEU:HD11	1:C:40:PRO:HD2	1.88	0.54
1:B:44:ARG:HG3	1:C:44:ARG:HH22	1.73	0.53
1:C:282:ARG:HG2	1:C:341:ILE:HD13	1.92	0.51
1:A:40:PRO:HD2	1:D:382:LEU:HD11	1.93	0.49
1:B:282:ARG:HG2	1:B:341:ILE:HD13	1.94	0.49
1:A:282:ARG:HG2	1:A:341:ILE:HD13	1.95	0.48
1:D:282:ARG:HG2	1:D:341:ILE:HD13	1.93	0.48
1:B:50:GLN:HG2	1:B:370:LEU:HD13	1.95	0.48
1:A:382:LEU:HD11	1:D:40:PRO:HD2	1.98	0.46
1:B:360:VAL:HG22	2:B:2138:HOH:O	2.17	0.44
1:C:44:ARG:HG2	2:C:2188:HOH:O	2.18	0.43
1:D:406:PRO:HB3	1:D:425:ALA:HB1	1.99	0.43
1:A:406:PRO:HB3	1:A:425:ALA:HB1	2.01	0.43
1:B:55:GLY:O	1:B:83:ALA:HB1	2.18	0.42
1:C:360:VAL:HG22	2:C:2180:HOH:O	2.19	0.42
1:A:252[B]:GLN:NE2	2:A:2030:HOH:O	2.52	0.42
1:C:337:ALA:O	1:C:341:ILE:HG12	2.20	0.42
1:C:406:PRO:HB3	1:C:425:ALA:HB1	2.02	0.42
1:C:55:GLY:O	1:C:83:ALA:HB1	2.20	0.41
1:B:406:PRO:HB3	1:B:425:ALA:HB1	2.02	0.41
1:A:55:GLY:O	1:A:83:ALA:HB1	2.20	0.41
1:D:50:GLN:HG2	1:D:370:LEU:CD1	2.50	0.41
1:D:337:ALA:O	1:D:341:ILE:HG12	2.21	0.41
1:B:329:LEU:HD23	1:B:329:LEU:HA	1.93	0.40
1:D:329:LEU:HD23	1:D:329:LEU:HA	1.97	0.40
1:B:337:ALA:O	1:B:341:ILE:HG12	2.21	0.40
1:D:439:VAL:HG11	1:D:454:LEU:HD13	2.03	0.40

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	433/474 (91%)	423 (98%)	10 (2%)	0	100	100
1	B	445/474 (94%)	435 (98%)	10 (2%)	0	100	100
1	C	439/474 (93%)	429 (98%)	10 (2%)	0	100	100
1	D	438/474 (92%)	428 (98%)	10 (2%)	0	100	100
All	All	1755/1896 (93%)	1715 (98%)	40 (2%)	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	313/362 (86%)	311 (99%)	2 (1%)	86	87
1	B	330/362 (91%)	328 (99%)	2 (1%)	86	87
1	C	325/362 (90%)	323 (99%)	2 (1%)	86	87
1	D	318/362 (88%)	316 (99%)	2 (1%)	86	87
All	All	1286/1448 (89%)	1278 (99%)	8 (1%)	86	87

All (8) residues with a non-rotameric sidechain are listed below:

Mol	Chain	Res	Type
1	A	111	ASN
1	A	379	VAL

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Mol	Chain	Res	Type
1	B	111	ASN
1	B	379	VAL
1	C	111	ASN
1	C	379	VAL
1	D	111	ASN
1	D	379	VAL

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, 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	440/474 (92%)	0.09	34 (7%) 13 14	19, 31, 77, 93	0
1	B	449/474 (94%)	0.18	36 (8%) 12 13	20, 33, 69, 106	0
1	C	445/474 (93%)	-0.24	9 (2%) 65 69	18, 27, 52, 110	0
1	D	444/474 (93%)	-0.21	22 (4%) 28 31	19, 27, 59, 101	0
All	All	1778/1896 (93%)	-0.04	101 (5%) 23 25	18, 30, 67, 110	0

All (101) RSRZ outliers are listed below:

Mol	Chain	Res	Type	RSRZ
1	C	12	ILE	6.0
1	B	418	TYR	5.9
1	D	12	ILE	5.7
1	A	414	SER	5.7
1	A	418	TYR	5.3
1	B	446	GLY	5.1
1	B	449	LEU	5.0
1	B	414	SER	4.9
1	A	421	ALA	4.8
1	B	447	ASP	4.8
1	B	444	LEU	4.7
1	A	12	ILE	4.6
1	B	416	ILE	4.6
1	D	10	TYR	4.3
1	A	417	GLY	4.3
1	C	447	ASP	4.2
1	C	24	ALA	4.1
1	B	443	GLY	4.1
1	D	24	ALA	4.1
1	B	451	ILE	4.1
1	A	449	LEU	3.8

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Mol	Chain	Res	Type	RSRZ
1	A	9	ASN	3.8
1	A	439	VAL	3.7
1	B	415	ALA	3.7
1	A	424	VAL	3.6
1	D	418	TYR	3.6
1	B	412	LEU	3.5
1	A	454	LEU	3.5
1	B	439	VAL	3.5
1	A	413	ASN	3.5
1	D	22	VAL	3.5
1	B	438	THR	3.5
1	B	422	ALA	3.4
1	A	425	ALA	3.4
1	D	466	ALA	3.4
1	B	448	ARG	3.4
1	B	466	ALA	3.4
1	A	453	ASP	3.4
1	D	14	HIS	3.3
1	D	445	ILE	3.3
1	A	466	ALA	3.3
1	D	11	ARG	3.3
1	A	415	ALA	3.2
1	B	445	ILE	3.2
1	A	411	PRO	3.1
1	C	10	TYR	3.1
1	A	423	ALA	3.1
1	A	450	SER	3.1
1	B	175	LEU	3.1
1	B	453	ASP	3.0
1	A	441	ASP	3.0
1	D	449	LEU	2.9
1	D	446	GLY	2.9
1	A	452	GLU	2.9
1	C	418	TYR	2.9
1	C	466	ALA	2.9
1	A	10	TYR	2.9
1	D	444	LEU	2.9
1	B	417	GLY	2.8
1	A	412	LEU	2.8
1	D	20	VAL	2.8
1	B	239	ASP	2.8
1	A	438	THR	2.7

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Mol	Chain	Res	Type	RSRZ
1	C	11	ARG	2.7
1	B	424	VAL	2.7
1	A	443	GLY	2.7
1	A	451	ILE	2.7
1	B	441	ASP	2.7
1	B	423	ALA	2.6
1	D	13	GLU	2.6
1	A	422	ALA	2.5
1	B	10	TYR	2.5
1	D	447	ASP	2.5
1	A	77	ASP	2.4
1	B	413	ASN	2.3
1	B	454	LEU	2.3
1	A	457	ARG	2.3
1	B	125	VAL	2.3
1	D	450	SER	2.3
1	A	442	ARG	2.3
1	A	409	VAL	2.3
1	A	24	ALA	2.2
1	B	409	VAL	2.2
1	B	440	ILE	2.2
1	B	429	LEU	2.2
1	D	314	LEU	2.2
1	D	23	PRO	2.2
1	B	425	ALA	2.2
1	B	450	SER	2.2
1	D	453	ASP	2.1
1	B	122	LYS	2.1
1	B	420	GLU	2.1
1	C	9	ASN	2.1
1	A	455	ASP	2.1
1	D	451	ILE	2.1
1	A	410	THR	2.0
1	C	345	ALA	2.0
1	D	448	ARG	2.0
1	A	426	LYS	2.0
1	D	9	ASN	2.0
1	B	457	ARG	2.0

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.