



# Full wwPDB X-ray Structure Validation Report ⓘ

Oct 8, 2023 – 10:21 AM EDT

PDB ID : 6EBT  
Title : Crystal structure of recombinant mutant N107T of human fumarase  
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Deposited on : 2018-08-07  
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](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>.

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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  
Mogul : 1.8.5 (274361), CSD as541be (2020)  
Xtrriage (Phenix) : 1.13  
EDS : 2.35.1  
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) : 2.35.1

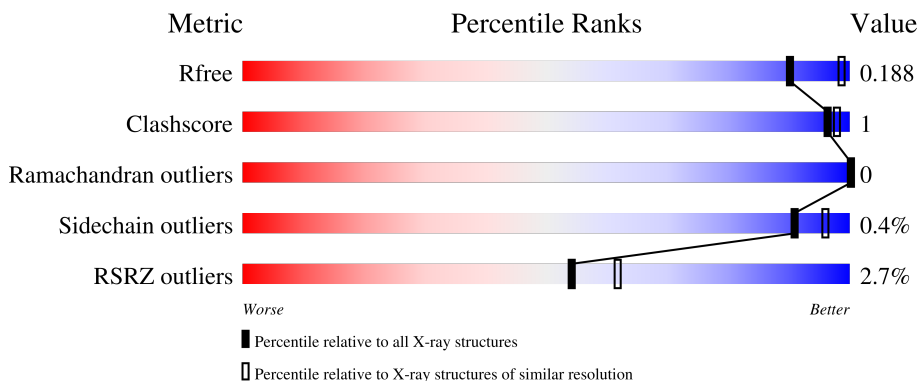
# 1 Overall quality at a glance

The following experimental techniques were used to determine the structure:

*X-RAY DIFFRACTION*

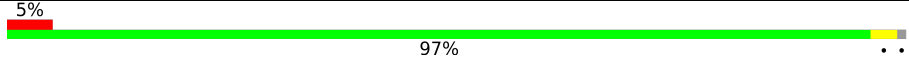
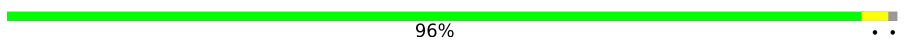
The reported resolution of this entry is 2.30 Å.

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))
$R_{free}$	130704	5042 (2.30-2.30)
Clashscore	141614	5643 (2.30-2.30)
Ramachandran outliers	138981	5575 (2.30-2.30)
Sidechain outliers	138945	5575 (2.30-2.30)
RSRZ outliers	127900	4938 (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  $\geq 3$ , 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	466	 5% 97%
1	B	466	 96%

## 2 Entry composition [i](#)

There are 3 unique types of molecules in this entry. The entry contains 14377 atoms, of which 6932 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, mitochondrial.

Mol	Chain	Residues	Atoms					ZeroOcc	AltConf	Trace	
			Total	C	H	N	O				S
1	A	462	6858	2172	3417	590	657	22	0	0	0
1	B	462	6961	2199	3475	599	665	23	0	8	0

There are 2 discrepancies between the modelled and reference sequences:

Chain	Residue	Modelled	Actual	Comment	Reference
A	107	THR	ASN	engineered mutation	UNP P07954
B	107	THR	ASN	engineered mutation	UNP P07954

- Molecule 2 is GLYCEROL (three-letter code: GOL) (formula: C<sub>3</sub>H<sub>8</sub>O<sub>3</sub>).



Mol	Chain	Residues	Atoms				ZeroOcc	AltConf
			Total	C	H	O		
2	A	1	14	3	8	3	0	0

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Mol	Chain	Residues	Atoms				ZeroOcc	AltConf
2	A	1	Total	C	H	O	0	0
			14	3	8	3		
2	B	1	Total	C	H	O	0	0
			14	3	8	3		
2	B	1	Total	C	H	O	0	0
			14	3	8	3		
2	B	1	Total	C	H	O	0	0
			14	3	8	3		

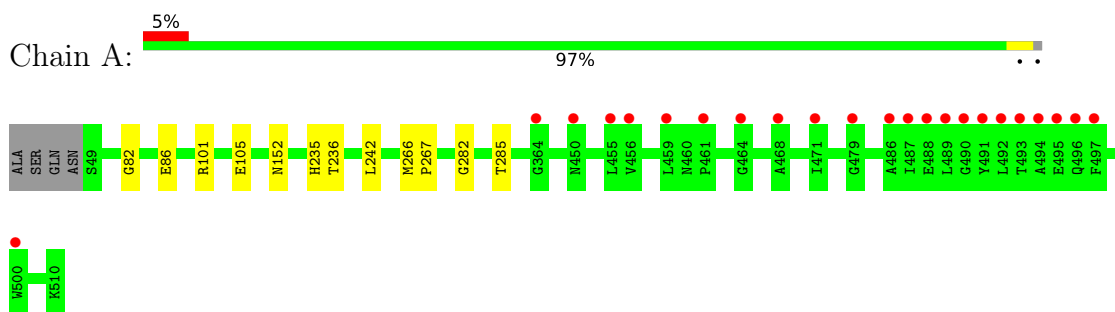
- Molecule 3 is water.

Mol	Chain	Residues	Atoms		ZeroOcc	AltConf
3	A	248	Total	O	0	0
			248	248		
3	B	240	Total	O	0	0
			240	240		

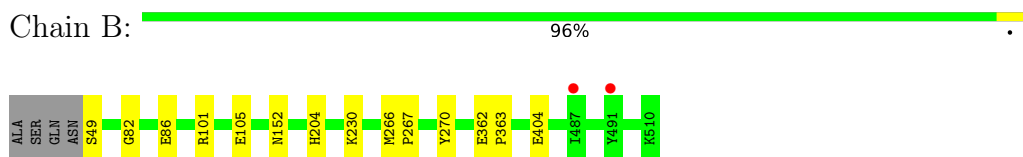
### 3 Residue-property plots [i](#)

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, mitochondrial



- Molecule 1: Fumarate hydratase, mitochondrial



## 4 Data and refinement statistics

Property	Value	Source
Space group	P 65 2 2	Depositor
Cell constants a, b, c, $\alpha$ , $\beta$ , $\gamma$	188.82Å 188.82Å 114.14Å 90.00° 90.00° 120.00°	Depositor
Resolution (Å)	93.60 – 2.30 93.60 – 2.30	Depositor EDS
% Data completeness (in resolution range)	100.0 (93.60-2.30) 100.0 (93.60-2.30)	Depositor EDS
$R_{merge}$	(Not available)	Depositor
$R_{sym}$	(Not available)	Depositor
$\langle I/\sigma(I) \rangle$ <sup>1</sup>	4.67 (at 2.29Å)	Xtrriage
Refinement program	PHENIX 1.11.1-2575-000	Depositor
R, $R_{free}$	0.150 , 0.185 0.151 , 0.188	Depositor DCC
$R_{free}$ test set	2656 reflections (4.96%)	wwPDB-VP
Wilson B-factor (Å <sup>2</sup> )	21.6	Xtrriage
Anisotropy	0.021	Xtrriage
Bulk solvent $k_{sol}$ (e/Å <sup>3</sup> ), $B_{sol}$ (Å <sup>2</sup> )	0.43 , 56.8	EDS
L-test for twinning <sup>2</sup>	$\langle  L  \rangle = 0.44$ , $\langle L^2 \rangle = 0.27$	Xtrriage
Estimated twinning fraction	No twinning to report.	Xtrriage
$F_o, F_c$ correlation	0.96	EDS
Total number of atoms	14377	wwPDB-VP
Average B, all atoms (Å <sup>2</sup> )	32.0	wwPDB-VP

Xtrriage's analysis on translational NCS is as follows: *The largest off-origin peak in the Patterson function is 4.25% 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](#)

Bond lengths and bond angles in the following residue types are not validated in this section: GOL

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	0.25	0/3504	0.42	0/4757
1	B	0.25	0/3568	0.42	0/4841
All	All	0.25	0/7072	0.42	0/9598

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	3441	3417	3405	6	0
1	B	3486	3475	3442	9	0
2	A	12	16	16	0	0
2	B	18	24	24	0	0
3	A	248	0	0	0	1
3	B	240	0	0	1	3
All	All	7445	6932	6887	14	4

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 (14) 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:101:ARG:NH1	1:A:105:GLU:OE1	2.21	0.72
1:B:101:ARG:NH1	1:B:105:GLU:OE1	2.23	0.70
1:B:362:GLU:HB3	1:B:363:PRO:CD	2.35	0.57
1:B:204:HIS:HE2	1:B:270:TYR:HH	1.53	0.54
1:A:266:MET:N	1:A:267:PRO:CD	2.76	0.49
1:B:362:GLU:HB3	1:B:363:PRO:HD2	1.94	0.49
1:B:266:MET:N	1:B:267:PRO:CD	2.77	0.47
1:B:204:HIS:NE2	1:B:270:TYR:OH	2.38	0.47
1:A:282:GLY:O	1:A:285:THR:HG22	2.15	0.46
1:A:82:GLY:HA3	1:A:86:GLU:HG3	1.98	0.45
1:A:242:LEU:HD21	1:B:404:GLU:CG	2.48	0.42
1:A:235:HIS:O	1:A:236:THR:OG1	2.33	0.42
1:B:49:SER:N	3:B:708:HOH:O	2.53	0.42
1:B:82:GLY:HA3	1:B:86:GLU:HG3	2.03	0.40

All (4) symmetry-related close contacts are listed below. The label for Atom-2 includes the symmetry operator and encoded unit-cell translations to be applied.

Atom-1	Atom-2	Interatomic distance (Å)	Clash overlap (Å)
3:B:888:HOH:O	3:B:909:HOH:O[12_544]	1.94	0.26
3:B:908:HOH:O	3:B:908:HOH:O[9_555]	1.96	0.24
3:A:859:HOH:O	3:A:908:HOH:O[12_544]	2.00	0.20
3:B:917:HOH:O	3:B:931:HOH:O[9_555]	2.02	0.18

## 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	460/466 (99%)	450 (98%)	10 (2%)	0	100	100
1	B	468/466 (100%)	458 (98%)	10 (2%)	0	100	100

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Mol	Chain	Analysed	Favoured	Allowed	Outliers	Percentiles	
All	All	928/932 (100%)	908 (98%)	20 (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	356/374 (95%)	355 (100%)	1 (0%)	92	97
1	B	365/374 (98%)	363 (100%)	2 (0%)	88	95
All	All	721/748 (96%)	718 (100%)	3 (0%)	91	96

All (3) residues with a non-rotameric sidechain are listed below:

Mol	Chain	Res	Type
1	A	152	ASN
1	B	152	ASN
1	B	230	LYS

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

5 ligands are modelled in this entry.

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	GOL	B	601	-	5,5,5	0.38	0	5,5,5	0.25	0
2	GOL	A	602	-	5,5,5	0.35	0	5,5,5	0.20	0
2	GOL	A	601	-	5,5,5	0.41	0	5,5,5	0.19	0
2	GOL	B	603	-	5,5,5	0.36	0	5,5,5	0.19	0
2	GOL	B	602	-	5,5,5	0.35	0	5,5,5	0.34	0

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. '2' means no outliers of that kind were identified.

Mol	Type	Chain	Res	Link	Chirals	Torsions	Rings
2	GOL	B	601	-	-	0/4/4/4	-
2	GOL	A	602	-	-	1/4/4/4	-
2	GOL	A	601	-	-	2/4/4/4	-
2	GOL	B	603	-	-	4/4/4/4	-
2	GOL	B	602	-	-	2/4/4/4	-

There are no bond length outliers.

There are no bond angle outliers.

There are no chirality outliers.

All (9) torsion outliers are listed below:

Mol	Chain	Res	Type	Atoms
2	A	601	GOL	O1-C1-C2-C3
2	B	602	GOL	O1-C1-C2-C3
2	B	603	GOL	O1-C1-C2-C3
2	B	603	GOL	C1-C2-C3-O3
2	B	602	GOL	O1-C1-C2-O2

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Mol	Chain	Res	Type	Atoms
2	B	603	GOL	O1-C1-C2-O2
2	A	601	GOL	O1-C1-C2-O2
2	A	602	GOL	O1-C1-C2-O2
2	B	603	GOL	O2-C2-C3-O3

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

### 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	462/466 (99%)	-0.21	23 (4%) 28 35	12, 24, 70, 92	1 (0%)
1	B	462/466 (99%)	-0.36	2 (0%) 92 95	11, 23, 61, 95	2 (0%)
All	All	924/932 (99%)	-0.29	25 (2%) 54 62	11, 23, 65, 95	3 (0%)

All (25) RSRZ outliers are listed below:

Mol	Chain	Res	Type	RSRZ
1	A	487	ILE	6.0
1	A	489	LEU	5.6
1	A	495	GLU	5.2
1	A	490	GLY	5.1
1	A	493	THR	4.1
1	A	492	LEU	3.9
1	A	488	GLU	3.9
1	A	491	TYR	3.6
1	A	459	LEU	3.6
1	A	455	LEU	3.6
1	A	500	TRP	3.6
1	A	468	ALA	3.3
1	A	494	ALA	3.3
1	A	456	VAL	3.0
1	A	464	GLY	2.7
1	A	450	ASN	2.7
1	B	487	ILE	2.6
1	A	497	PHE	2.5
1	A	496	GLN	2.5
1	B	491	TYR	2.4
1	A	486	ALA	2.3
1	A	479	GLY	2.3
1	A	461	PRO	2.3
1	A	364	GLY	2.2

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Mol	Chain	Res	Type	RSRZ
1	A	471	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 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, 95<sup>th</sup> 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 <sup>2</sup> )	Q<0.9
2	GOL	A	602	6/6	0.87	0.19	35,50,73,73	0
2	GOL	B	601	6/6	0.88	0.14	38,56,75,80	0
2	GOL	B	603	6/6	0.88	0.17	47,62,78,78	0
2	GOL	B	602	6/6	0.89	0.18	27,40,60,72	0
2	GOL	A	601	6/6	0.89	0.17	33,56,69,75	0

## 6.5 Other polymers [i](#)

There are no such residues in this entry.