



wwPDB X-ray Structure Validation Summary Report ⓘ

Aug 7, 2023 – 04:03 AM EDT

PDB ID : 1KQ7
Title : E315Q Mutant Form of Fumarase C from E.coli
Authors : Weaver, T.M.; Estevez, M.; Skarda, J.; Spencer, J.
Deposited on : 2002-01-04
Resolution : 2.60 Å(reported)

This is a wwPDB X-ray Structure Validation Summary 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
Mogul : 1.8.5 (274361), CSD as541be (2020)
Xtrriage (Phenix) : 1.13
EDS : 2.35
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

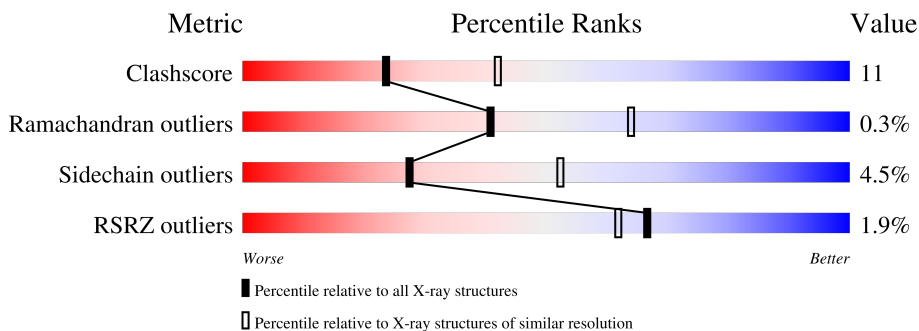
1 Overall quality at a glance

The following experimental techniques were used to determine the structure:

X-RAY DIFFRACTION

The reported resolution of this entry is 2.60 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))
Clashscore	141614	3518 (2.60-2.60)
Ramachandran outliers	138981	3455 (2.60-2.60)
Sidechain outliers	138945	3455 (2.60-2.60)
RSRZ outliers	127900	3104 (2.60-2.60)

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	467	
1	B	467	

The following table lists non-polymeric compounds, carbohydrate monomers and non-standard residues in protein, DNA, RNA chains that are outliers for geometric or electron-density-fit criteria:

Mol	Type	Chain	Res	Chirality	Geometry	Clashes	Electron density
2	MLT	A	468	X	-	X	-
3	CIT	A	469	-	X	-	-

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Mol	Type	Chain	Res	Chirality	Geometry	Clashes	Electron density
3	CIT	B	468	-	X	X	X

2 Entry composition [i](#)

There are 4 unique types of molecules in this entry. The entry contains 6960 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.

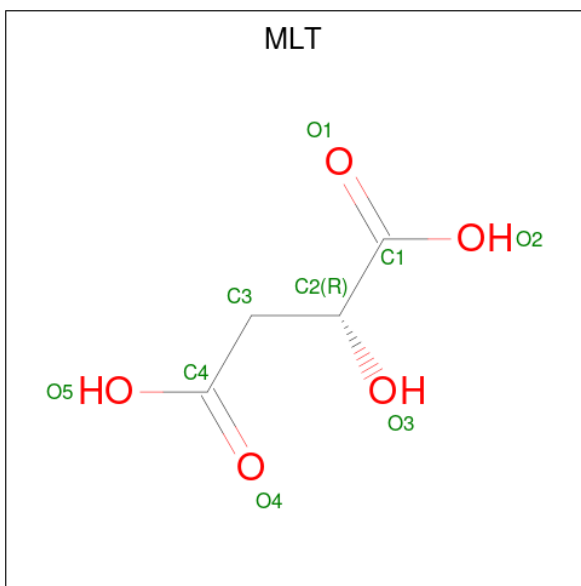
- Molecule 1 is a protein called FUMARATE HYDRATASE CLASS II.

Mol	Chain	Residues	Atoms					ZeroOcc	AltConf	Trace
			Total	C	N	O	S			
1	A	456	Total 3456	C 2158	N 618	O 657	S 23	0	0	0
1	B	455	Total 3451	C 2155	N 617	O 655	S 24	0	0	0

There are 2 discrepancies between the modelled and reference sequences:

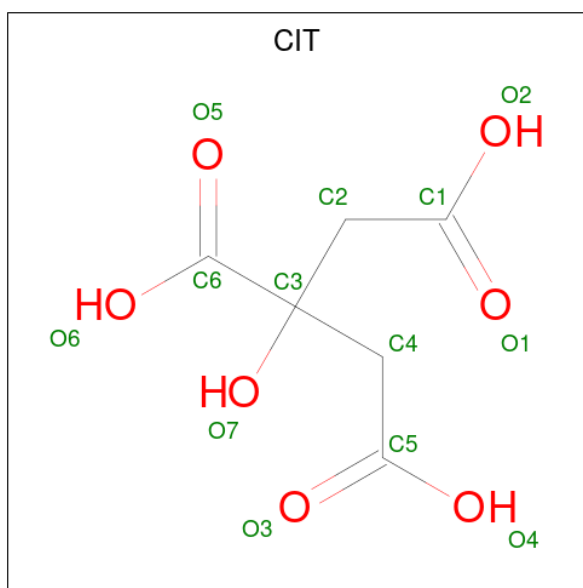
Chain	Residue	Modelled	Actual	Comment	Reference
A	315	GLN	GLU	engineered mutation	UNP P05042
B	315	GLN	GLU	engineered mutation	UNP P05042

- Molecule 2 is D-MALATE (three-letter code: MLT) (formula: C₄H₆O₅).



Mol	Chain	Residues	Atoms			ZeroOcc	AltConf
			Total	C	O		
2	A	1	Total 9	C 4	O 5	0	0

- Molecule 3 is CITRIC ACID (three-letter code: CIT) (formula: $C_6H_8O_7$).



Mol	Chain	Residues	Atoms	ZeroOcc	AltConf
3	A	1	Total C O 13 6 7	0	0
3	B	1	Total C O 13 6 7	0	0

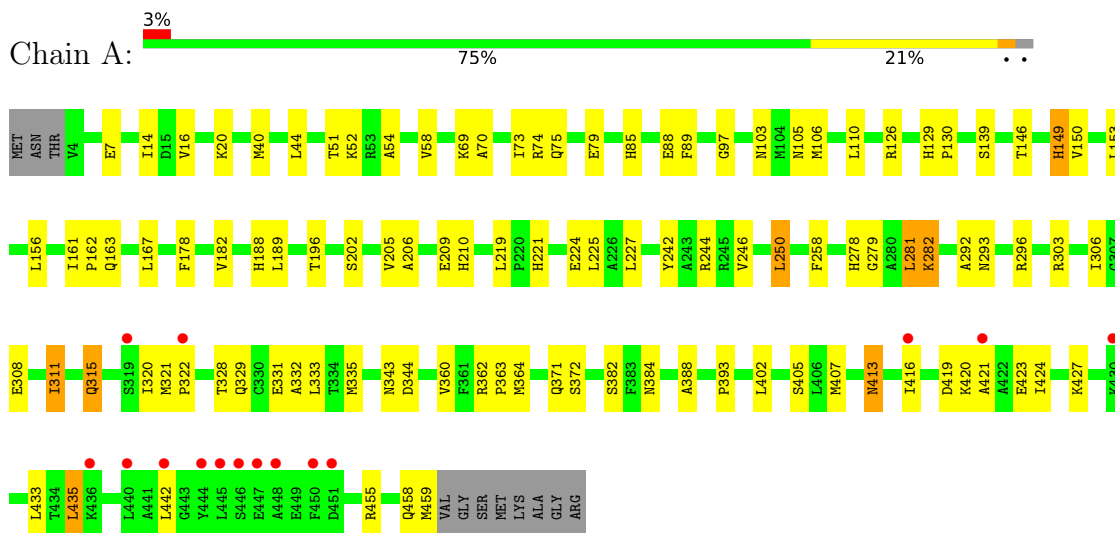
- Molecule 4 is water.

Mol	Chain	Residues	Atoms	ZeroOcc	AltConf
4	A	8	Total O 8 8	0	0
4	B	10	Total O 10 10	0	0

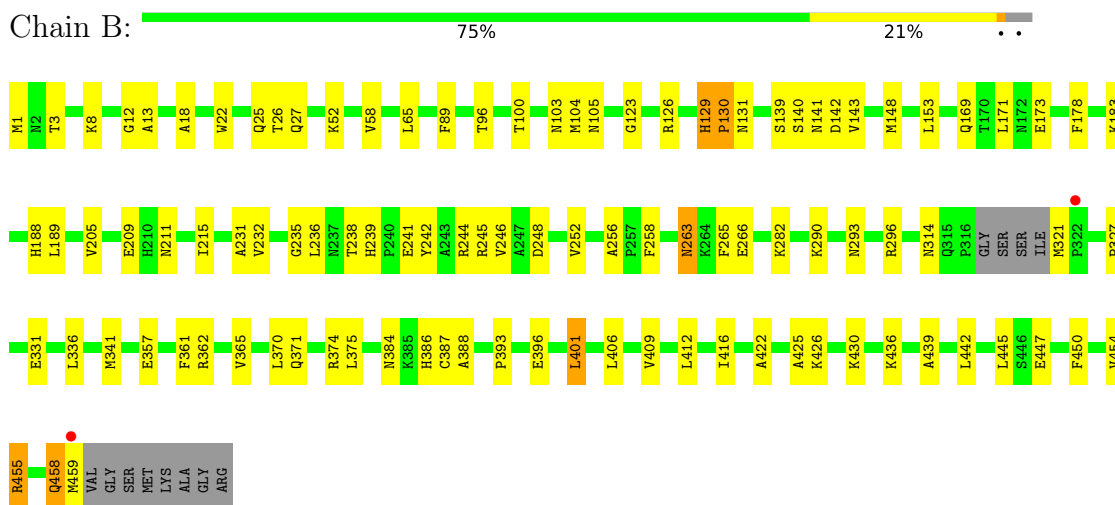
3 Residue-property plots

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



• Molecule 1: FUMARATE HYDRATASE CLASS II



4 Data and refinement statistics

Property	Value	Source
Space group	C 2 2 21	Depositor
Cell constants a, b, c, α , β , γ	104.02Å 220.00Å 86.23Å 90.00° 90.00° 90.00°	Depositor
Resolution (Å)	8.00 – 2.60 47.02 – 2.58	Depositor EDS
% Data completeness (in resolution range)	(Not available) (8.00-2.60) 74.9 (47.02-2.58)	Depositor EDS
R_{merge}	0.11	Depositor
R_{sym}	0.18	Depositor
$\langle I/\sigma(I) \rangle$ ¹	0.87 (at 2.58Å)	Xtrriage
Refinement program	X-PLOR 3.851	Depositor
R, R_{free}	0.179 , 0.251 0.191 , (Not available)	Depositor DCC
R_{free} test set	No test flags present.	wwPDB-VP
Wilson B-factor (Å ²)	16.2	Xtrriage
Anisotropy	0.274	Xtrriage
Bulk solvent k_{sol} (e/Å ³), B_{sol} (Å ²)	0.30 , 30.9	EDS
L-test for twinning ²	$\langle L \rangle = 0.47$, $\langle L^2 \rangle = 0.29$	Xtrriage
Estimated twinning fraction	No twinning to report.	Xtrriage
F_o, F_c correlation	0.91	EDS
Total number of atoms	6960	wwPDB-VP
Average B, all atoms (Å ²)	14.0	wwPDB-VP

Xtrriage's analysis on translational NCS is as follows: *The largest off-origin peak in the Patterson function is 5.08% 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

5.1 Standard geometry

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

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	0.28	0/3514	0.52	0/4760
1	B	0.30	0/3508	0.54	0/4751
All	All	0.29	0/7022	0.53	0/9511

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

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	3456	0	3475	74	0
1	B	3451	0	3469	70	0
2	A	9	0	3	4	0
3	A	13	0	2	1	0
3	B	13	0	8	16	0
4	A	8	0	0	0	0
4	B	10	0	0	0	0
All	All	6960	0	6957	155	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 11.

The worst 5 of 155 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)
3:B:468:CIT:C4	3:B:468:CIT:C5	2.17	1.22
3:B:468:CIT:C1	3:B:468:CIT:C2	2.20	1.19
3:B:468:CIT:C6	3:B:468:CIT:C3	2.22	1.18
3:B:468:CIT:C4	3:B:468:CIT:C3	2.22	1.17
3:B:468:CIT:C2	3:B:468:CIT:C3	2.23	1.16

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	454/467 (97%)	432 (95%)	22 (5%)	0	100	100
1	B	451/467 (97%)	423 (94%)	25 (6%)	3 (1%)	22	43
All	All	905/934 (97%)	855 (94%)	47 (5%)	3 (0%)	41	64

All (3) Ramachandran outliers are listed below:

Mol	Chain	Res	Type
1	B	231	ALA
1	B	387	CYS
1	B	130	PRO

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	368/376 (98%)	353 (96%)	15 (4%)	30	56
1	B	367/376 (98%)	349 (95%)	18 (5%)	25	48
All	All	735/752 (98%)	702 (96%)	33 (4%)	27	52

5 of 33 residues with a non-rotameric sidechain are listed below:

Mol	Chain	Res	Type
1	B	401	LEU
1	B	442	LEU
1	B	459	MET
1	A	433	LEU
1	A	413	ASN

Sometimes sidechains can be flipped to improve hydrogen bonding and reduce clashes. 5 of 41 such sidechains are listed below:

Mol	Chain	Res	Type
1	B	239	HIS
1	B	368	ASN
1	B	263	ASN
1	B	314	ASN
1	B	384	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 monosaccharides in this entry.

5.6 Ligand geometry [i](#)

3 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	MLT	A	468	-	8,8,8	1.16	0	10,10,10	3.82	4 (40%)
3	CIT	B	468	-	12,12,12	35.67	12 (100%)	17,17,17	5.98	13 (76%)
3	CIT	A	469	-	12,12,12	4.52	5 (41%)	17,17,17	6.06	10 (58%)

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

Mol	Type	Chain	Res	Link	Chirals	Torsions	Rings
2	MLT	A	468	-	1/1/3/3	3/8/8/8	-
3	CIT	B	468	-	-	7/16/16/16	-
3	CIT	A	469	-	-	9/16/16/16	-

The worst 5 of 17 bond length outliers are listed below:

Mol	Chain	Res	Type	Atoms	Z	Observed(Å)	Ideal(Å)
3	B	468	CIT	C3-C6	66.42	2.22	1.53
3	B	468	CIT	C2-C3	56.02	2.23	1.53
3	B	468	CIT	C4-C3	54.87	2.22	1.53
3	B	468	CIT	O7-C3	30.26	2.01	1.43
3	B	468	CIT	O5-C6	23.76	1.98	1.22

The worst 5 of 27 bond angle outliers are listed below:

Mol	Chain	Res	Type	Atoms	Z	Observed(°)	Ideal(°)
3	B	468	CIT	C4-C3-C6	-14.65	78.62	110.11
3	A	469	CIT	C3-C4-C5	14.06	147.86	113.81
3	A	469	CIT	C3-C2-C1	13.17	145.71	113.81
3	A	469	CIT	C4-C3-C6	-11.19	86.05	110.11
2	A	468	MLT	O3-C2-C3	10.67	136.23	110.05

All (1) chirality outliers are listed below:

Mol	Chain	Res	Type	Atom
2	A	468	MLT	C2

5 of 19 torsion outliers are listed below:

Mol	Chain	Res	Type	Atoms
2	A	468	MLT	O1-C1-C2-O3
2	A	468	MLT	O2-C1-C2-O3
2	A	468	MLT	O3-C2-C3-C4
3	A	469	CIT	C1-C2-C3-O7
3	A	469	CIT	C1-C2-C3-C4

There are no ring outliers.

3 monomers are involved in 21 short contacts:

Mol	Chain	Res	Type	Clashes	Symm-Clashes
2	A	468	MLT	4	0
3	B	468	CIT	16	0
3	A	469	CIT	1	0

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	456/467 (97%)	-0.19	15 (3%) 46 39	2, 9, 68, 82	0
1	B	455/467 (97%)	-0.52	2 (0%) 92 91	2, 8, 29, 70	0
All	All	911/934 (97%)	-0.35	17 (1%) 66 62	2, 8, 57, 82	0

The worst 5 of 17 RSRZ outliers are listed below:

Mol	Chain	Res	Type	RSRZ
1	A	322	PRO	3.7
1	A	447	GLU	3.6
1	A	450	PHE	3.5
1	A	440	LEU	3.3
1	A	448	ALA	3.3

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, 95th 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(\AA^2)	Q<0.9
3	CIT	B	468	13/13	0.61	0.59	55,64,69,70	0
2	MLT	A	468	9/9	0.79	0.27	39,42,45,46	0
3	CIT	A	469	13/13	0.83	0.27	54,58,60,61	0

6.5 Other polymers [i](#)

There are no such residues in this entry.