



wwPDB X-ray Structure Validation Summary Report ⓘ

Mar 5, 2026 – 11:30 AM UTC

PDB ID : 6HKE / pdb_00006hke
Title : MatC (Rpa3494) from Rhodopseudomonas palustris with bound malate
Authors : Rosa, L.T.; Dix, S.; Rafferty, J.B.; Kelly, D.J.
Deposited on : 2018-09-06
Resolution : 2.11 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	:	4-5-2 with Phenix2.0
Mogul	:	2022.3.0, CSD as543be (2022)
Xtriage (Phenix)	:	2.0
EDS	:	3.0
Percentile statistics	:	20250101.v01 (using entries in the PDB archive January 1st 2025)
CCP4	:	9.0.010 (Gargrove)
Density-Fitness	:	1.0.12
Ideal geometry (proteins)	:	Engh & Huber (2001)
Ideal geometry (DNA, RNA)	:	Parkinson et al. (1996)
Validation Pipeline (wwPDB-VP)	:	2.49

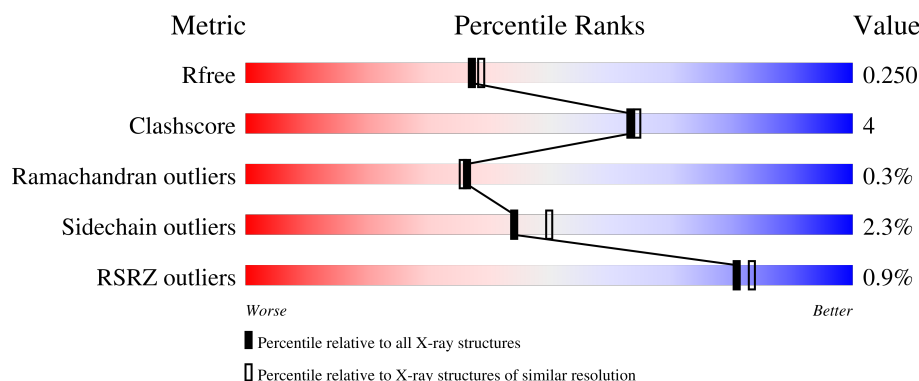
1 Overall quality at a glance

The following experimental techniques were used to determine the structure:

X-RAY DIFFRACTION

The reported resolution of this entry is 2.11 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}	180053	8290 (2.14-2.10)
Clashscore	190562	8817 (2.14-2.10)
Ramachandran outliers	187476	8738 (2.14-2.10)
Sidechain outliers	187428	8739 (2.14-2.10)
RSRZ outliers	180081	8294 (2.14-2.10)

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 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	318	82%10%8%
1	B	318	81%12%7%
1	C	318	84%8%7%

2 Entry composition

There are 4 unique types of molecules in this entry. The entry contains 6770 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 Possible TctC subunit of the Tripartite Tricarboxylate Transport(TTT) Family.

Mol	Chain	Residues	Atoms					ZeroOcc	AltConf	Trace
1	A	294	Total	C	N	O	S	0	0	0
			2198	1402	382	408	6			
1	B	296	Total	C	N	O	S	0	0	0
			2203	1405	381	411	6			
1	C	295	Total	C	N	O	S	0	0	0
			2202	1404	383	409	6			

There are 39 discrepancies between the modelled and reference sequences:

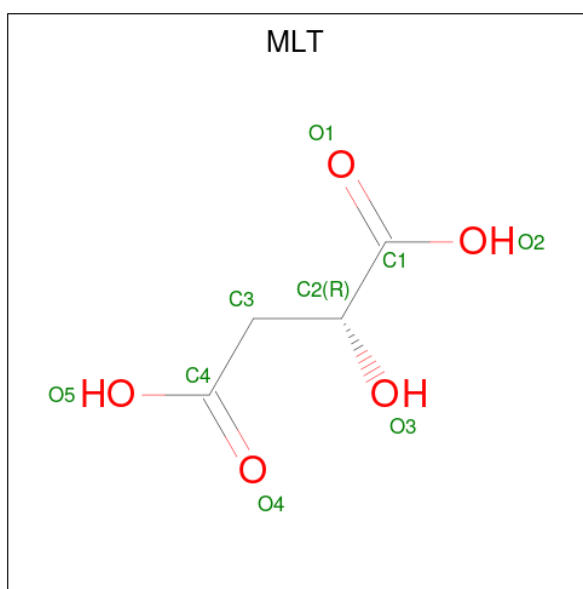
Chain	Residue	Modelled	Actual	Comment	Reference
A	1	MET	-	initiating methionine	UNP Q6N446
A	2	ALA	-	expression tag	UNP Q6N446
A	3	SER	-	expression tag	UNP Q6N446
A	134	GLU	LYS	engineered mutation	UNP Q6N446
A	306	GLU	LYS	engineered mutation	UNP Q6N446
A	311	LEU	-	expression tag	UNP Q6N446
A	312	GLU	-	expression tag	UNP Q6N446
A	313	HIS	-	expression tag	UNP Q6N446
A	314	HIS	-	expression tag	UNP Q6N446
A	315	HIS	-	expression tag	UNP Q6N446
A	316	HIS	-	expression tag	UNP Q6N446
A	317	HIS	-	expression tag	UNP Q6N446
A	318	HIS	-	expression tag	UNP Q6N446
B	1	MET	-	initiating methionine	UNP Q6N446
B	2	ALA	-	expression tag	UNP Q6N446
B	3	SER	-	expression tag	UNP Q6N446
B	134	GLU	LYS	engineered mutation	UNP Q6N446
B	306	GLU	LYS	engineered mutation	UNP Q6N446
B	311	LEU	-	expression tag	UNP Q6N446
B	312	GLU	-	expression tag	UNP Q6N446
B	313	HIS	-	expression tag	UNP Q6N446
B	314	HIS	-	expression tag	UNP Q6N446

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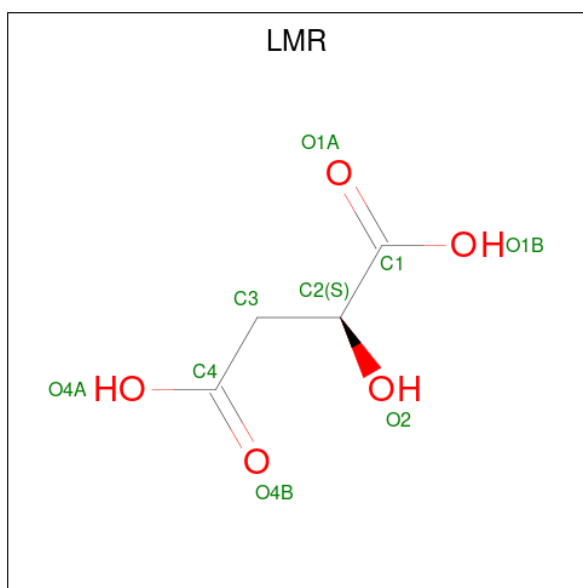
Chain	Residue	Modelled	Actual	Comment	Reference
B	315	HIS	-	expression tag	UNP Q6N446
B	316	HIS	-	expression tag	UNP Q6N446
B	317	HIS	-	expression tag	UNP Q6N446
B	318	HIS	-	expression tag	UNP Q6N446
C	1	MET	-	initiating methionine	UNP Q6N446
C	2	ALA	-	expression tag	UNP Q6N446
C	3	SER	-	expression tag	UNP Q6N446
C	134	GLU	LYS	engineered mutation	UNP Q6N446
C	306	GLU	LYS	engineered mutation	UNP Q6N446
C	311	LEU	-	expression tag	UNP Q6N446
C	312	GLU	-	expression tag	UNP Q6N446
C	313	HIS	-	expression tag	UNP Q6N446
C	314	HIS	-	expression tag	UNP Q6N446
C	315	HIS	-	expression tag	UNP Q6N446
C	316	HIS	-	expression tag	UNP Q6N446
C	317	HIS	-	expression tag	UNP Q6N446
C	318	HIS	-	expression tag	UNP Q6N446

- Molecule 2 is D-MALATE (CCD ID: MLT) (formula: $C_4H_6O_5$).



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

- Molecule 3 is (2S)-2-hydroxybutanedioic acid (CCD ID: LMR) (formula: $C_4H_6O_5$).



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

- Molecule 4 is water.

Mol	Chain	Residues	Atoms		ZeroOcc	AltConf
4	A	51	Total	O	0	0
			51	51		
4	B	29	Total	O	0	0
			29	29		
4	C	33	Total	O	0	0
			33	33		

- Molecule 1: Possible TctC subunit of the Tripartite Tricarboxylate Transport(TTT) Family



4 Data and refinement statistics

Property	Value	Source
Space group	P 21 21 21	Depositor
Cell constants a, b, c, α , β , γ	80.80Å 205.75Å 47.62Å 90.00° 90.00° 90.00°	Depositor
Resolution (Å)	63.54 – 2.11 63.54 – 2.11	Depositor EDS
% Data completeness (in resolution range)	88.7 (63.54-2.11) 88.7 (63.54-2.11)	Depositor EDS
R_{merge}	0.05	Depositor
R_{sym}	(Not available)	Depositor
$\langle I/\sigma(I) \rangle$ ¹	1.85 (at 2.10Å)	Xtriage
Refinement program	REFMAC 5.8.0238	Depositor
R, R_{free}	0.191 , 0.248 0.200 , 0.250	Depositor DCC
R_{free} test set	1941 reflections (4.67%)	wwPDB-VP
Wilson B-factor (Å ²)	30.2	Xtriage
Anisotropy	0.778	Xtriage
Bulk solvent k_{sol} (e/Å ³), B_{sol} (Å ²)	0.36 , 27.0	EDS
L-test for twinning ²	$\langle L \rangle = 0.47$, $\langle L^2 \rangle = 0.30$	Xtriage
Estimated twinning fraction	No twinning to report.	Xtriage
F_o, F_c correlation	0.95	EDS
Total number of atoms	6770	wwPDB-VP
Average B, all atoms (Å ²)	31.0	wwPDB-VP

Xtriage's analysis on translational NCS is as follows: *The largest off-origin peak in the Patterson function is 4.07% 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](#)

Bond lengths and bond angles in the following residue types are not validated in this section: LMR, 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	1.00	0/2247	1.44	4/3075 (0.1%)
1	B	1.00	0/2252	1.44	1/3083 (0.0%)
1	C	1.01	0/2251	1.45	9/3080 (0.3%)
All	All	1.01	0/6750	1.45	14/9238 (0.2%)

There are no bond length outliers.

The worst 5 of 14 bond angle outliers are listed below:

Mol	Chain	Res	Type	Atoms	Z	Observed(°)	Ideal(°)
1	A	122	PRO	N-CA-C	7.07	119.32	110.70
1	C	15	VAL	N-CA-C	-6.07	107.34	113.47
1	C	146	GLY	CA-C-O	-5.96	117.81	122.52
1	C	122	PRO	N-CA-C	5.96	117.97	110.70
1	B	122	PRO	N-CA-C	5.92	117.92	110.70

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	2198	0	2236	17	0
1	B	2203	0	2235	25	0
1	C	2202	0	2239	11	0

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Mol	Chain	Non-H	H(model)	H(added)	Clashes	Symm-Clashes
2	A	9	0	4	1	0
2	B	9	0	4	0	0
2	C	9	0	4	0	0
3	A	9	0	4	1	0
3	B	9	0	4	0	0
3	C	9	0	4	0	0
4	A	51	0	0	0	0
4	B	29	0	0	1	0
4	C	33	0	0	0	0
All	All	6770	0	6734	53	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 4.

The worst 5 of 53 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:269:ARG:O	1:B:273:THR:HG22	1.91	0.70
1:B:90:LEU:CD2	1:B:305:VAL:HG21	2.25	0.66
1:C:281:ARG:NH1	1:C:284:GLN:HE22	1.95	0.65
1:B:266:SER:O	1:B:270:THR:HG23	2.01	0.60
1:B:234:GLN:O	1:B:300:ARG:NH2	2.32	0.60

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	292/318 (92%)	287 (98%)	4 (1%)	1 (0%)	36	36
1	B	294/318 (92%)	287 (98%)	6 (2%)	1 (0%)	36	36

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Mol	Chain	Analysed	Favoured	Allowed	Outliers	Percentiles	
1	C	293/318 (92%)	288 (98%)	4 (1%)	1 (0%)	36	36
All	All	879/954 (92%)	862 (98%)	14 (2%)	3 (0%)	36	36

All (3) Ramachandran outliers are listed below:

Mol	Chain	Res	Type
1	B	85	GLY
1	C	85	GLY
1	A	85	GLY

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	233/255 (91%)	228 (98%)	5 (2%)	47	54
1	B	233/255 (91%)	228 (98%)	5 (2%)	47	54
1	C	233/255 (91%)	227 (97%)	6 (3%)	40	45
All	All	699/765 (91%)	683 (98%)	16 (2%)	44	50

5 of 16 residues with a non-rotameric sidechain are listed below:

Mol	Chain	Res	Type
1	C	300	ARG
1	C	283	GLU
1	B	155	CYS
1	C	273	THR
1	B	138	ASP

Sometimes sidechains can be flipped to improve hydrogen bonding and reduce clashes. All (5) such sidechains are listed below:

Mol	Chain	Res	Type
1	A	136	HIS
1	A	265	GLN

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Mol	Chain	Res	Type
1	B	47	GLN
1	B	192	GLN
1	B	284	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 ⓘ

There are no oligosaccharides in this entry.

5.6 Ligand geometry ⓘ

6 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	$\# Z > 2$
3	LMR	A	402[B]	-	8,8,8	1.08	0	10,10,10	1.61	2 (20%)
2	MLT	B	401[A]	-	8,8,8	1.28	0	10,10,10	1.85	4 (40%)
3	LMR	C	402[B]	-	8,8,8	1.11	0	10,10,10	1.60	2 (20%)
2	MLT	A	401[A]	-	8,8,8	1.16	0	10,10,10	2.24	5 (50%)
2	MLT	C	401[A]	-	8,8,8	1.09	0	10,10,10	2.05	3 (30%)
3	LMR	B	402[B]	-	8,8,8	1.11	0	10,10,10	1.38	2 (20%)

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
3	LMR	A	402[B]	-	-	2/8/8/8	-
2	MLT	B	401[A]	-	-	6/8/8/8	-
3	LMR	C	402[B]	-	-	2/8/8/8	-
2	MLT	A	401[A]	-	-	4/8/8/8	-
2	MLT	C	401[A]	-	-	2/8/8/8	-
3	LMR	B	402[B]	-	-	5/8/8/8	-

There are no bond length outliers.

The worst 5 of 18 bond angle outliers are listed below:

Mol	Chain	Res	Type	Atoms	Z	Observed(°)	Ideal(°)
2	C	401[A]	MLT	O2-C1-C2	4.43	122.11	112.74
2	A	401[A]	MLT	O2-C1-C2	3.90	120.98	112.74
2	A	401[A]	MLT	C2-C3-C4	-3.34	103.35	112.08
3	C	402[B]	LMR	O1A-C1-C2	-3.26	116.09	122.60
2	A	401[A]	MLT	O3-C2-C3	-3.02	102.69	109.96

There are no chirality outliers.

5 of 21 torsion outliers are listed below:

Mol	Chain	Res	Type	Atoms
2	B	401[A]	MLT	O1-C1-C2-O3
2	B	401[A]	MLT	O2-C1-C2-O3
2	A	401[A]	MLT	O2-C1-C2-O3
3	A	402[B]	LMR	O1B-C1-C2-O2
2	A	401[A]	MLT	O1-C1-C2-C3

There are no ring outliers.

2 monomers are involved in 2 short contacts:

Mol	Chain	Res	Type	Clashes	Symm-Clashes
3	A	402[B]	LMR	1	0
2	A	401[A]	MLT	1	0

5.7 Other polymers [i](#)

There are no such residues in this entry.

5.8 Polymer linkage issues

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	294/318 (92%)	0.00	2 (0%) 84 86	20, 28, 48, 66	0
1	B	296/318 (93%)	0.07	4 (1%) 73 76	21, 29, 46, 75	0
1	C	295/318 (92%)	0.09	2 (0%) 84 86	21, 30, 46, 74	0
All	All	885/954 (92%)	0.05	8 (0%) 81 83	20, 29, 47, 75	0

The worst 5 of 8 RSRZ outliers are listed below:

Mol	Chain	Res	Type	RSRZ
1	B	92	PRO	3.7
1	C	93	LYS	3.2
1	C	92	PRO	3.1
1	B	91	PHE	2.8
1	A	305	VAL	2.8

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 oligosaccharides 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($\text{\AA}^2$)	Q<0.9
3	LMR	B	402[B]	9/9	0.85	0.14	39,41,44,45	9
3	LMR	C	402[B]	9/9	0.88	0.09	21,24,24,25	9
3	LMR	A	402[B]	9/9	0.89	0.10	20,21,22,23	9
2	MLT	C	401[A]	9/9	0.90	0.09	24,25,26,26	9
2	MLT	B	401[A]	9/9	0.93	0.08	16,18,19,19	9
2	MLT	A	401[A]	9/9	0.94	0.09	23,25,27,27	9

6.5 Other polymers [i](#)

There are no such residues in this entry.