



# wwPDB X-ray Structure Validation Summary Report ⓘ

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PDB ID : 2OG9 / pdb\_00002og9  
Title : Crystal Structure of mandelate racemase/muconate lactonizing enzyme from *Polaromonas* sp. JS666  
Authors : Kumaran, D.; Burley, S.K.; Swaminathan, S.; New York SGX Research Center for Structural Genomics (NYSGXRC)  
Deposited on : 2007-01-05  
Resolution : 1.90 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](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 : 4-5-2 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

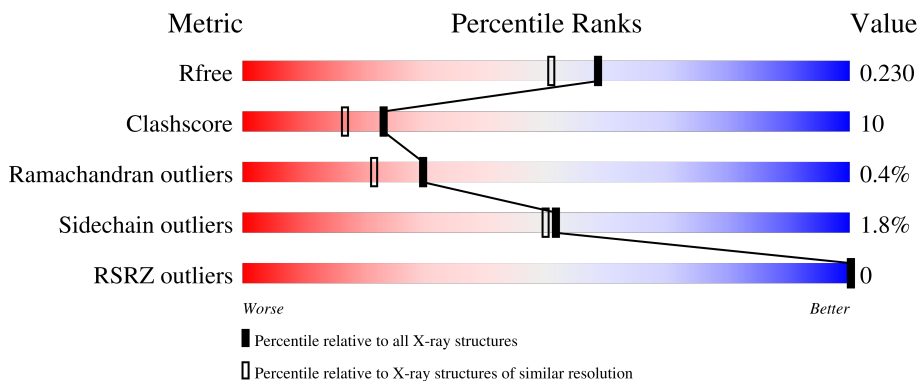
# 1 Overall quality at a glance

The following experimental techniques were used to determine the structure:

*X-RAY DIFFRACTION*



The reported resolution of this entry is 1.90 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	7789 (1.90-1.90)
Clashscore	190562	8410 (1.90-1.90)
Ramachandran outliers	187476	8333 (1.90-1.90)
Sidechain outliers	187428	8333 (1.90-1.90)
RSRZ outliers	180081	7790 (1.90-1.90)

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	393	 74% 16% • 8%
1	B	393	 74% 17% • 8%

## 2 Entry composition [i](#)

There are 3 unique types of molecules in this entry. The entry contains 5943 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 Mandelate racemase/muconate lactonizing enzyme.

Mol	Chain	Residues	Atoms						ZeroOcc	AltConf	Trace
			Total	C	N	O	S	Se			
1	A	363	2791	1776	497	505	4	9	0	0	0
1	B	363	2791	1776	497	505	4	9	0	0	0

There are 40 discrepancies between the modelled and reference sequences:

Chain	Residue	Modelled	Actual	Comment	Reference
A	1	MSE	-	cloning artifact	UNP Q12GE3
A	2	SER	-	cloning artifact	UNP Q12GE3
A	3	LEU	-	cloning artifact	UNP Q12GE3
A	44	MSE	MET	modified residue	UNP Q12GE3
A	167	MSE	MET	modified residue	UNP Q12GE3
A	211	MSE	MET	modified residue	UNP Q12GE3
A	226	MSE	MET	modified residue	UNP Q12GE3
A	266	MSE	MET	modified residue	UNP Q12GE3
A	286	MSE	MET	modified residue	UNP Q12GE3
A	311	MSE	MET	modified residue	UNP Q12GE3
A	318	MSE	MET	modified residue	UNP Q12GE3
A	355	MSE	MET	modified residue	UNP Q12GE3
A	386	GLU	-	cloning artifact	UNP Q12GE3
A	387	GLY	-	cloning artifact	UNP Q12GE3
A	388	HIS	-	cloning artifact	UNP Q12GE3
A	389	HIS	-	cloning artifact	UNP Q12GE3
A	390	HIS	-	cloning artifact	UNP Q12GE3
A	391	HIS	-	cloning artifact	UNP Q12GE3
A	392	HIS	-	cloning artifact	UNP Q12GE3
A	393	HIS	-	cloning artifact	UNP Q12GE3
B	1	MSE	-	cloning artifact	UNP Q12GE3
B	2	SER	-	cloning artifact	UNP Q12GE3
B	3	LEU	-	cloning artifact	UNP Q12GE3
B	44	MSE	MET	modified residue	UNP Q12GE3
B	167	MSE	MET	modified residue	UNP Q12GE3

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Chain	Residue	Modelled	Actual	Comment	Reference
B	211	MSE	MET	modified residue	UNP Q12GE3
B	226	MSE	MET	modified residue	UNP Q12GE3
B	266	MSE	MET	modified residue	UNP Q12GE3
B	286	MSE	MET	modified residue	UNP Q12GE3
B	311	MSE	MET	modified residue	UNP Q12GE3
B	318	MSE	MET	modified residue	UNP Q12GE3
B	355	MSE	MET	modified residue	UNP Q12GE3
B	386	GLU	-	cloning artifact	UNP Q12GE3
B	387	GLY	-	cloning artifact	UNP Q12GE3
B	388	HIS	-	cloning artifact	UNP Q12GE3
B	389	HIS	-	cloning artifact	UNP Q12GE3
B	390	HIS	-	cloning artifact	UNP Q12GE3
B	391	HIS	-	cloning artifact	UNP Q12GE3
B	392	HIS	-	cloning artifact	UNP Q12GE3
B	393	HIS	-	cloning artifact	UNP Q12GE3

- Molecule 2 is CALCIUM ION (CCD ID: CA) (formula: Ca).

Mol	Chain	Residues	Atoms	ZeroOcc	AltConf
2	A	1	Total Ca 1 1	0	0
2	B	1	Total Ca 1 1	0	0

- Molecule 3 is water.

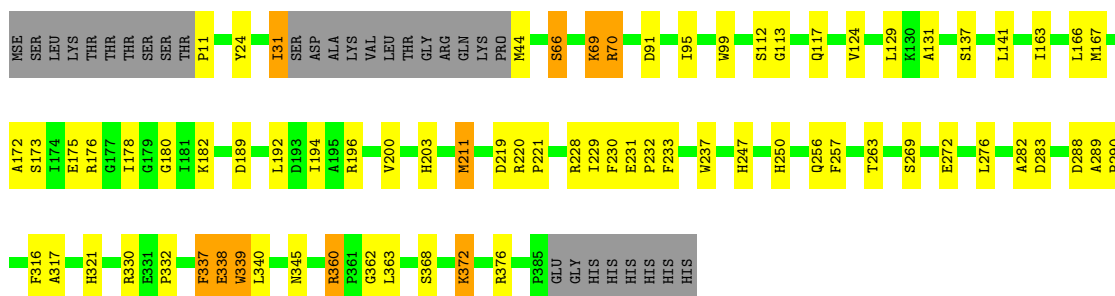
Mol	Chain	Residues	Atoms	ZeroOcc	AltConf
3	A	169	Total O 169 169	0	0
3	B	190	Total O 190 190	0	0

### 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.

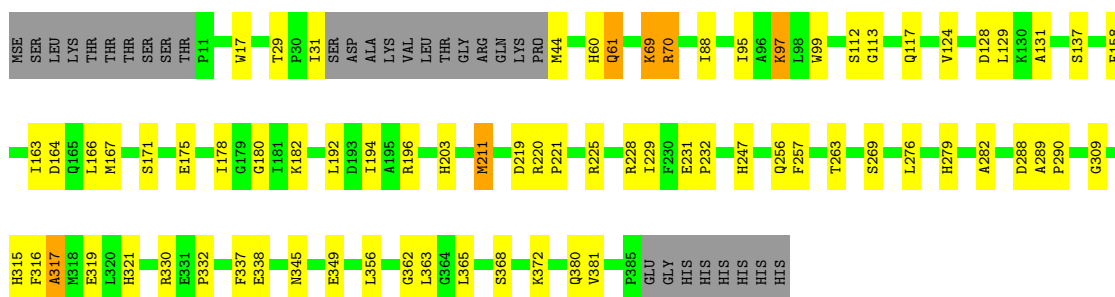
- Molecule 1: Mandelate racemase/muconate lactonizing enzyme

Chain A: 



- Molecule 1: Mandelate racemase/muconate lactonizing enzyme

Chain B: 



## 4 Data and refinement statistics i

Property	Value	Source
Space group	I 4	Depositor
Cell constants a, b, c, $\alpha$ , $\beta$ , $\gamma$	133.42Å 133.42Å 87.43Å 90.00° 90.00° 90.00°	Depositor
Resolution (Å)	23.84 – 1.90 23.84 – 1.90	Depositor EDS
% Data completeness (in resolution range)	99.8 (23.84-1.90) 99.9 (23.84-1.90)	Depositor EDS
$R_{merge}$	(Not available)	Depositor
$R_{sym}$	0.09	Depositor
$\langle I/\sigma(I) \rangle$ <sup>1</sup>	3.08 (at 1.90Å)	Xtrriage
Refinement program	CNS 1.1	Depositor
R, $R_{free}$	0.203 , 0.230 0.203 , 0.230	Depositor DCC
$R_{free}$ test set	2436 reflections (4.04%)	wwPDB-VP
Wilson B-factor (Å <sup>2</sup> )	24.1	Xtrriage
Anisotropy	0.147	Xtrriage
Bulk solvent $k_{sol}$ (e/Å <sup>3</sup> ), $B_{sol}$ (Å <sup>2</sup> )	0.37 , 32.3	EDS
L-test for twinning <sup>2</sup>	$\langle  L  \rangle = 0.50$ , $\langle L^2 \rangle = 0.33$	Xtrriage
Estimated twinning fraction	0.488 for -k,-h,-l	Xtrriage
$F_o, F_c$ correlation	0.97	EDS
Total number of atoms	5943	wwPDB-VP
Average B, all atoms (Å <sup>2</sup> )	28.0	wwPDB-VP

Xtrriage's analysis on translational NCS is as follows: *The largest off-origin peak in the Patterson function is 3.68% 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: CA

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	0.37	0/2854	0.88	10/3865 (0.3%)
1	B	0.36	0/2854	0.87	7/3865 (0.2%)
All	All	0.37	0/5708	0.88	17/7730 (0.2%)

There are no bond length outliers.

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

Mol	Chain	Res	Type	Atoms	Z	Observed(°)	Ideal(°)
1	A	338	GLU	N-CA-C	7.73	122.53	113.18
1	A	339	TRP	N-CA-C	7.58	120.51	111.33
1	B	95	ILE	N-CA-C	6.88	117.02	110.42
1	A	95	ILE	N-CA-C	6.77	116.92	110.42
1	B	137	SER	N-CA-C	-6.02	103.00	110.41

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	2791	0	2767	63	0
1	B	2791	0	2767	51	0
2	A	1	0	0	0	0
2	B	1	0	0	0	0

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Mol	Chain	Non-H	H(model)	H(added)	Clashes	Symm-Clashes
3	A	169	0	0	3	0
3	B	190	0	0	7	0
All	All	5943	0	5534	114	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 10.

The worst 5 of 114 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:167:MSE:HE3	1:B:203:HIS:HB2	1.59	0.83
1:A:167:MSE:HE3	1:A:203:HIS:HB2	1.62	0.81
1:A:182:LYS:HE2	3:A:473:HOH:O	1.82	0.78
1:A:289:ALA:HB3	1:A:290:PRO:HD3	1.68	0.76
1:A:289:ALA:H	1:A:321:HIS:HE1	1.36	0.74

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	359/393 (91%)	349 (97%)	9 (2%)	1 (0%)	36	29
1	B	359/393 (91%)	348 (97%)	9 (2%)	2 (1%)	21	13
All	All	718/786 (91%)	697 (97%)	18 (2%)	3 (0%)	30	22

All (3) Ramachandran outliers are listed below:

Mol	Chain	Res	Type
1	A	70	ARG
1	B	317	ALA

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Mol	Chain	Res	Type
1	B	70	ARG

### 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	283/300 (94%)	278 (98%)	5 (2%)	51	50
1	B	283/300 (94%)	278 (98%)	5 (2%)	51	50
All	All	566/600 (94%)	556 (98%)	10 (2%)	51	50

5 of 10 residues with a non-rotameric sidechain are listed below:

Mol	Chain	Res	Type
1	B	164	ASP
1	B	192	LEU
1	B	211	MSE
1	A	360	ARG
1	A	372	LYS

Sometimes sidechains can be flipped to improve hydrogen bonding and reduce clashes. 5 of 19 such sidechains are listed below:

Mol	Chain	Res	Type
1	B	279	HIS
1	B	345	ASN
1	B	380	GLN
1	B	321	HIS
1	A	345	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 oligosaccharides in this entry.

## 5.6 Ligand geometry [i](#)

Of 2 ligands modelled in this entry, 2 are monoatomic - leaving 0 for Mogul analysis.

There are no bond length outliers.

There are no bond angle outliers.

There are no chirality outliers.

There are no torsion outliers.

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 [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, 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	354/393 (90%)	-1.34	0 <a href="#">100</a> <a href="#">100</a>	15, 25, 47, 53	0
1	B	354/393 (90%)	-1.34	0 <a href="#">100</a> <a href="#">100</a>	15, 25, 47, 52	0
All	All	708/786 (90%)	-1.34	0 <a href="#">100</a> <a href="#">100</a>	15, 25, 47, 53	0

There are no RSRZ outliers to report.

### 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, 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	CA	A	401	1/1	1.00	0.02	28,28,28,28	0
2	CA	B	402	1/1	1.00	0.02	26,26,26,26	0

### 6.5 Other polymers [i](#)

There are no such residues in this entry.