



wwPDB X-ray Structure Validation Summary Report ⓘ

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PDB ID : 4YIO / pdb_00004yio
Title : X-ray structure of the iron/manganese cambialistic superoxide dismutase from *Streptococcus thermophilus*
Authors : Russo Krauss, I.; Merlino, A.; Pica, A.; Sica, F.
Deposited on : 2015-03-02
Resolution : 1.60 Å(reported)

This is a wwPDB X-ray Structure Validation Summary Report for a publicly released PDB entry.

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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

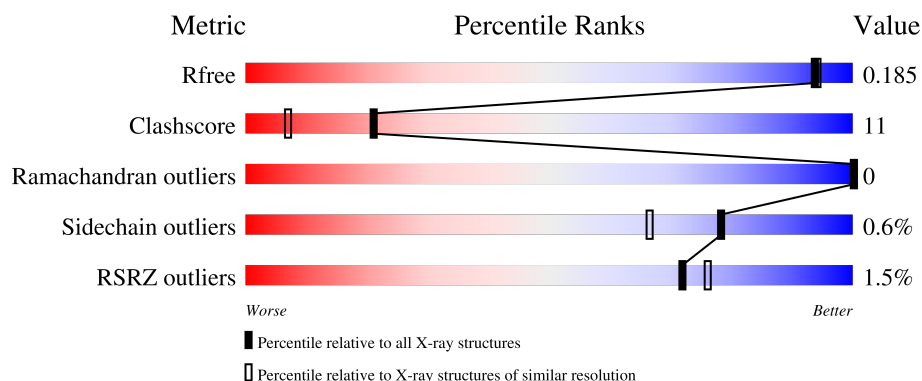
1 Overall quality at a glance

The following experimental techniques were used to determine the structure:

X-RAY DIFFRACTION

The reported resolution of this entry is 1.60 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))
R_{free}	180053	4673 (1.60-1.60)
Clashscore	190562	4931 (1.60-1.60)
Ramachandran outliers	187476	4831 (1.60-1.60)
Sidechain outliers	187428	4830 (1.60-1.60)
RSRZ outliers	180081	4672 (1.60-1.60)

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	208	% 80% 17% .
1	B	208	2% 75% 19% ..

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
4	GOL	A	307	-	-	X	-
4	GOL	B	304	-	-	X	-

2 Entry composition

There are 5 unique types of molecules in this entry. The entry contains 3892 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 Superoxide dismutase.

Mol	Chain	Residues	Atoms					ZeroOcc	AltConf	Trace
1	A	202	Total	C	N	O	S	0	6	0
			1639	1061	264	313	1			
1	B	201	Total	C	N	O	S	0	5	0
			1617	1047	261	308	1			

There are 16 discrepancies between the modelled and reference sequences:

Chain	Residue	Modelled	Actual	Comment	Reference
A	200	LEU	-	expression tag	UNP Q5M4Z1
A	201	GLU	-	expression tag	UNP Q5M4Z1
A	202	HIS	-	expression tag	UNP Q5M4Z1
A	203	HIS	-	expression tag	UNP Q5M4Z1
A	204	HIS	-	expression tag	UNP Q5M4Z1
A	205	HIS	-	expression tag	UNP Q5M4Z1
A	206	HIS	-	expression tag	UNP Q5M4Z1
A	207	HIS	-	expression tag	UNP Q5M4Z1
B	200	LEU	-	expression tag	UNP Q5M4Z1
B	201	GLU	-	expression tag	UNP Q5M4Z1
B	202	HIS	-	expression tag	UNP Q5M4Z1
B	203	HIS	-	expression tag	UNP Q5M4Z1
B	204	HIS	-	expression tag	UNP Q5M4Z1
B	205	HIS	-	expression tag	UNP Q5M4Z1
B	206	HIS	-	expression tag	UNP Q5M4Z1
B	207	HIS	-	expression tag	UNP Q5M4Z1

- Molecule 2 is FE (III) ION (CCD ID: FE) (formula: Fe).

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

- Molecule 3 is SULFATE ION (CCD ID: SO4) (formula: O₄S).



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

- Molecule 4 is GLYCEROL (CCD ID: GOL) (formula: C₃H₈O₃).



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

- Molecule 5 is water.

Mol	Chain	Residues	Atoms		ZeroOcc	AltConf
5	A	265	Total	O	0	3
			268	268		
5	B	287	Total	O	0	7
			294	294		

4 Data and refinement statistics

Property	Value	Source
Space group	C 2 2 21	Depositor
Cell constants a, b, c, α , β , γ	98.52Å 100.23Å 118.12Å 90.00° 90.00° 90.00°	Depositor
Resolution (Å)	27.89 – 1.60 27.89 – 1.60	Depositor EDS
% Data completeness (in resolution range)	95.6 (27.89-1.60) 95.6 (27.89-1.60)	Depositor EDS
R_{merge}	0.05	Depositor
R_{sym}	(Not available)	Depositor
$\langle I/\sigma(I) \rangle$ ¹	2.19 (at 1.60Å)	Xtriage
Refinement program	REFMAC 5.8.0049	Depositor
R, R_{free}	0.156 , 0.175 0.170 , 0.185	Depositor DCC
R_{free} test set	3798 reflections (4.93%)	wwPDB-VP
Wilson B-factor (Å ²)	17.6	Xtriage
Anisotropy	0.411	Xtriage
Bulk solvent k_{sol} (e/Å ³), B_{sol} (Å ²)	0.37 , 44.4	EDS
L-test for twinning ²	$\langle L \rangle = 0.49$, $\langle L^2 \rangle = 0.32$	Xtriage
Estimated twinning fraction	0.024 for -k,-h,-l	Xtriage
F_o, F_c correlation	0.97	EDS
Total number of atoms	3892	wwPDB-VP
Average B, all atoms (Å ²)	23.0	wwPDB-VP

Xtriage's analysis on translational NCS is as follows: *The largest off-origin peak in the Patterson function is 5.39% 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: FE, SO4, 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	1.66	11/1703 (0.6%)	1.37	2/2327 (0.1%)
1	B	1.74	21/1677 (1.3%)	1.48	6/2294 (0.3%)
All	All	1.70	32/3380 (0.9%)	1.43	8/4621 (0.2%)

The worst 5 of 32 bond length outliers are listed below:

Mol	Chain	Res	Type	Atoms	Z	Observed(Å)	Ideal(Å)
1	B	62	ILE	CA-C	8.30	1.61	1.52
1	B	100	ALA	C-O	6.94	1.32	1.24
1	B	5	PRO	C-O	6.87	1.31	1.23
1	B	188	ASN	CG-ND2	-6.27	1.20	1.33
1	B	83	PHE	N-CA	-6.19	1.38	1.46

The worst 5 of 8 bond angle outliers are listed below:

Mol	Chain	Res	Type	Atoms	Z	Observed(°)	Ideal(°)
1	B	64	ALA	N-CA-C	9.08	123.37	111.75
1	B	20	ALA	N-CA-C	6.09	117.91	111.28
1	B	60	GLU	N-CA-C	-5.95	106.00	113.20
1	B	103	ASN	CA-C-O	-5.93	114.13	120.42
1	A	75	GLY	N-CA-C	-5.66	105.93	112.50

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	1639	0	1588	28	0
1	B	1617	0	1573	36	0
2	A	1	0	0	0	0
2	B	1	0	0	0	0
3	A	20	0	0	0	0
3	B	10	0	0	0	0
4	A	18	0	23	9	0
4	B	24	0	32	11	0
5	A	268	0	0	16	0
5	B	294	0	0	26	2
All	All	3892	0	3216	72	2

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 72 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)
4:B:304:GOL:O1	5:B:401:HOH:O	1.57	1.21
1:A:91:LYS:HE3	5:A:572:HOH:O	1.53	1.08
1:B:15[B]:GLU:OE2	5:B:677:HOH:O	1.71	1.05
1:B:198:GLU:OE1	5:B:561:HOH:O	1.75	1.04
1:B:153:ASP:HB3	5:B:616:HOH:O	1.57	1.03

All (2) 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)
5:B:461:HOH:O	5:B:461:HOH:O[3_555]	1.78	0.42
5:B:416:HOH:O	5:B:452:HOH:O[3_555]	1.90	0.30

5.3 Torsion angles ⓘ

5.3.1 Protein backbone ⓘ

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	206/208 (99%)	202 (98%)	4 (2%)	0	100	100
1	B	204/208 (98%)	197 (97%)	7 (3%)	0	100	100
All	All	410/416 (99%)	399 (97%)	11 (3%)	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	170/170 (100%)	170 (100%)	0	100	100
1	B	168/170 (99%)	166 (99%)	2 (1%)	63	43
All	All	338/340 (99%)	336 (99%)	2 (1%)	78	66

All (2) residues with a non-rotameric sidechain are listed below:

Mol	Chain	Res	Type
1	B	61	LYS
1	B	201	GLU

Sometimes sidechains can be flipped to improve hydrogen bonding and reduce clashes. All (4) such sidechains are listed below:

Mol	Chain	Res	Type
1	A	45	HIS
1	A	68	GLN
1	A	113	GLN
1	A	188	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 15 ligands modelled in this entry, 2 are monoatomic - leaving 13 for Mogul analysis.

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	$\# Z > 2$
4	GOL	A	306	-	5,5,5	0.77	0	5,5,5	2.04	1 (20%)
4	GOL	B	306	-	5,5,5	1.30	0	5,5,5	1.04	0
4	GOL	B	307	-	5,5,5	1.32	1 (20%)	5,5,5	1.40	0
3	SO4	A	304	-	4,4,4	0.68	0	6,6,6	1.11	1 (16%)
4	GOL	A	307	-	5,5,5	1.22	0	5,5,5	1.32	0
4	GOL	A	308	-	5,5,5	0.82	0	5,5,5	0.92	0
3	SO4	A	302	-	4,4,4	0.74	0	6,6,6	0.78	0
3	SO4	A	303	-	4,4,4	0.41	0	6,6,6	0.64	0
3	SO4	B	302	-	4,4,4	0.33	0	6,6,6	1.14	1 (16%)
4	GOL	B	305	-	5,5,5	0.64	0	5,5,5	2.09	2 (40%)
3	SO4	A	305	-	4,4,4	0.72	0	6,6,6	0.80	0
4	GOL	B	304	-	5,5,5	1.05	0	5,5,5	1.40	2 (40%)
3	SO4	B	303	-	4,4,4	0.34	0	6,6,6	0.92	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. '-' means no outliers of that kind were identified.

Mol	Type	Chain	Res	Link	Chirals	Torsions	Rings
4	GOL	A	306	-	-	3/4/4/4	-
4	GOL	B	306	-	-	0/4/4/4	-
4	GOL	A	307	-	-	3/4/4/4	-
4	GOL	A	308	-	-	0/4/4/4	-
4	GOL	B	305	-	-	2/4/4/4	-
4	GOL	B	304	-	-	0/4/4/4	-
4	GOL	B	307	-	-	0/4/4/4	-

All (1) bond length outliers are listed below:

Mol	Chain	Res	Type	Atoms	Z	Observed(Å)	Ideal(Å)
4	B	307	GOL	O2-C2	2.08	1.49	1.43

The worst 5 of 7 bond angle outliers are listed below:

Mol	Chain	Res	Type	Atoms	Z	Observed(°)	Ideal(°)
4	A	306	GOL	C3-C2-C1	-4.05	96.93	111.80
4	B	305	GOL	O3-C3-C2	-3.36	95.25	110.38
3	A	304	SO4	O4-S-O3	-2.31	95.78	108.54
3	B	302	SO4	O3-S-O1	2.26	121.36	109.56
4	B	305	GOL	O2-C2-C1	-2.25	99.86	109.18

There are no chirality outliers.

5 of 8 torsion outliers are listed below:

Mol	Chain	Res	Type	Atoms
4	A	306	GOL	C1-C2-C3-O3
4	A	307	GOL	O1-C1-C2-C3
4	A	307	GOL	C1-C2-C3-O3
4	B	305	GOL	C1-C2-C3-O3
4	A	306	GOL	O2-C2-C3-O3

There are no ring outliers.

7 monomers are involved in 20 short contacts:

Mol	Chain	Res	Type	Clashes	Symm-Clashes
4	A	306	GOL	2	0
4	B	306	GOL	1	0
4	B	307	GOL	1	0
4	A	307	GOL	4	0
4	A	308	GOL	3	0

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Mol	Chain	Res	Type	Clashes	Symm-Clashes
4	B	305	GOL	1	0
4	B	304	GOL	8	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	202/208 (97%)	-0.09	2 (0%) 79 83	11, 19, 35, 72	6 (2%)
1	B	201/208 (96%)	-0.16	4 (1%) 65 69	10, 18, 36, 57	5 (2%)
All	All	403/416 (96%)	-0.13	6 (1%) 72 76	10, 18, 36, 72	11 (2%)

The worst 5 of 6 RSRZ outliers are listed below:

Mol	Chain	Res	Type	RSRZ
1	B	135	ALA	3.9
1	A	202	HIS	3.6
1	A	1	ALA	2.8
1	B	198	GLU	2.5
1	B	61	LYS	2.3

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 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	SO4	A	303	5/5	0.80	0.12	50,58,64,68	5
4	GOL	B	305	6/6	0.81	0.17	35,39,54,56	0
3	SO4	A	305	5/5	0.82	0.15	41,45,50,51	5
4	GOL	A	308	6/6	0.84	0.16	29,39,52,60	0
4	GOL	B	306	6/6	0.85	0.13	26,37,38,44	0
4	GOL	B	304	6/6	0.86	0.17	23,31,51,52	0
4	GOL	A	306	6/6	0.89	0.11	33,37,42,43	0
3	SO4	A	304	5/5	0.90	0.10	27,35,39,43	5
4	GOL	B	307	6/6	0.91	0.10	26,34,35,36	0
4	GOL	A	307	6/6	0.93	0.09	25,31,44,45	0
3	SO4	B	303	5/5	0.95	0.09	26,27,30,31	5
3	SO4	A	302	5/5	0.97	0.08	22,27,33,36	5
3	SO4	B	302	5/5	0.97	0.06	27,33,36,43	0
2	FE	B	301	1/1	0.99	0.01	15,15,15,15	0
2	FE	A	301	1/1	1.00	0.01	14,14,14,14	0

6.5 Other polymers [i](#)

There are no such residues in this entry.