



# wwPDB X-ray Structure Validation Summary Report ⓘ

Mar 5, 2026 – 03:38 PM UTC

PDB ID : 9VAR / pdb\_00009var  
Title : Crystal structure of Cu-bound artificial metalloprotein incorporating a TP ligand  
Authors : Lee, Y.J.; Song, W.J.  
Deposited on : 2025-06-04  
Resolution : 2.86 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)

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<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

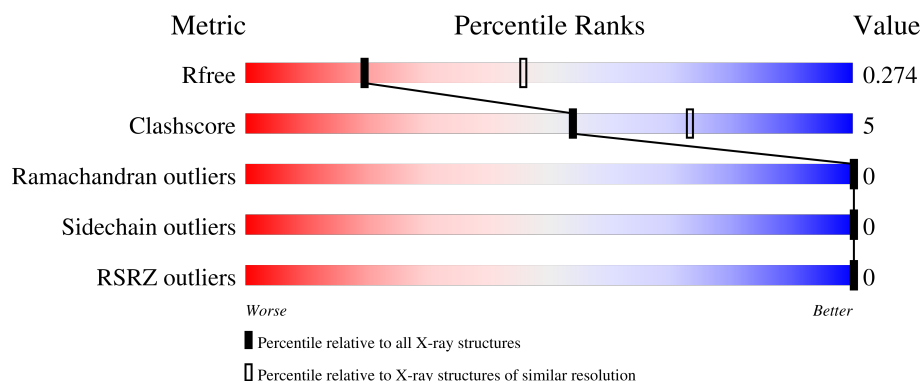
# 1 Overall quality at a glance

The following experimental techniques were used to determine the structure:

*X-RAY DIFFRACTION*




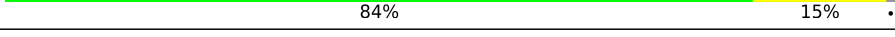
The reported resolution of this entry is 2.86 Å.

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	1407 (2.88-2.84)
Clashscore	190562	1446 (2.88-2.84)
Ramachandran outliers	187476	1406 (2.88-2.84)
Sidechain outliers	187428	1407 (2.88-2.84)
RSRZ outliers	180081	1408 (2.88-2.84)

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	188	 83% 16% .
1	B	188	 82% 15% .
1	C	188	 85% 12% .
1	D	188	 84% 15% .

## 2 Entry composition

There are 5 unique types of molecules in this entry. The entry contains 6352 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 dTDP-4-dehydrorhamnose 3,5-epimerase.

Mol	Chain	Residues	Atoms					ZeroOcc	AltConf	Trace
1	A	187	Total	C	N	O	S	0	0	0
			1558	995	261	296	6			
1	B	183	Total	C	N	O	S	0	0	0
			1529	978	255	291	5			
1	C	183	Total	C	N	O	S	0	0	0
			1529	978	255	291	5			
1	D	187	Total	C	N	O	S	0	0	0
			1558	995	261	296	6			

There are 16 discrepancies between the modelled and reference sequences:

Chain	Residue	Modelled	Actual	Comment	Reference
A	-2	GLY	-	expression tag	UNP O27818
A	-1	SER	-	expression tag	UNP O27818
A	0	HIS	-	expression tag	UNP O27818
A	79	A1L97	ARG	engineered mutation	UNP O27818
B	-2	GLY	-	expression tag	UNP O27818
B	-1	SER	-	expression tag	UNP O27818
B	0	HIS	-	expression tag	UNP O27818
B	79	A1L97	ARG	engineered mutation	UNP O27818
C	-2	GLY	-	expression tag	UNP O27818
C	-1	SER	-	expression tag	UNP O27818
C	0	HIS	-	expression tag	UNP O27818
C	79	A1L97	ARG	engineered mutation	UNP O27818
D	-2	GLY	-	expression tag	UNP O27818
D	-1	SER	-	expression tag	UNP O27818
D	0	HIS	-	expression tag	UNP O27818
D	79	A1L97	ARG	engineered mutation	UNP O27818

- Molecule 2 is COPPER (II) ION (CCD ID: CU) (formula: Cu).

Mol	Chain	Residues	Atoms	ZeroOcc	AltConf
2	A	1	Total Cu 1 1	0	0
2	B	1	Total Cu 1 1	0	0
2	C	1	Total Cu 1 1	0	0
2	D	1	Total Cu 1 1	0	0

- Molecule 3 is SODIUM ION (CCD ID: NA) (formula: Na).

Mol	Chain	Residues	Atoms	ZeroOcc	AltConf
3	B	1	Total Na 1 1	0	0
3	C	1	Total Na 1 1	0	0

- Molecule 4 is SULFATE ION (CCD ID: SO4) (formula: O<sub>4</sub>S).



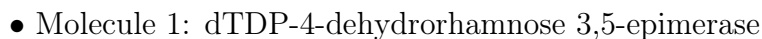
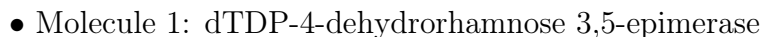
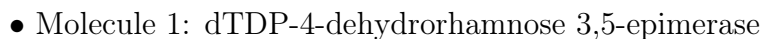
Mol	Chain	Residues	Atoms	ZeroOcc	AltConf
4	C	1	Total O S 5 4 1	0	0

- Molecule 5 is water.

Mol	Chain	Residues	Atoms		ZeroOcc	AltConf
5	A	41	Total 41	O 41	0	0
5	B	46	Total 46	O 46	0	0
5	C	45	Total 45	O 45	0	0
5	D	35	Total 35	O 35	0	0



- Molecule 1: dTDP-4-dehydrorhamnose 3,5-epimerase



## 4 Data and refinement statistics

Property	Value	Source
Space group	P 1	Depositor
Cell constants a, b, c, $\alpha$ , $\beta$ , $\gamma$	51.58Å 72.74Å 63.52Å 90.05° 113.49° 89.89°	Depositor
Resolution (Å)	29.13 – 2.86 29.13 – 2.86	Depositor EDS
% Data completeness (in resolution range)	93.0 (29.13-2.86) 92.5 (29.13-2.86)	Depositor EDS
$R_{merge}$	(Not available)	Depositor
$R_{sym}$	(Not available)	Depositor
$\langle I/\sigma(I) \rangle$ <sup>1</sup>	3.14 (at 2.85Å)	Xtriage
Refinement program	PHENIX 1.21.2_5419	Depositor
R, $R_{free}$	0.225 , 0.274 0.225 , 0.274	Depositor DCC
$R_{free}$ test set	908 reflections (4.65%)	wwPDB-VP
Wilson B-factor (Å <sup>2</sup> )	37.1	Xtriage
Anisotropy	0.756	Xtriage
Bulk solvent $k_{sol}$ (e/Å <sup>3</sup> ), $B_{sol}$ (Å <sup>2</sup> )	0.40 , 40.9	EDS
L-test for twinning <sup>2</sup>	$\langle  L  \rangle = 0.48$ , $\langle L^2 \rangle = 0.31$	Xtriage
Estimated twinning fraction	0.128 for h,-k,-h-l 0.408 for -h,k,-l 0.139 for -h,-k,h+l	Xtriage
$F_o, F_c$ correlation	0.96	EDS
Total number of atoms	6352	wwPDB-VP
Average B, all atoms (Å <sup>2</sup> )	38.0	wwPDB-VP

Xtriage's analysis on translational NCS is as follows: *The largest off-origin peak in the Patterson function is 6.25% 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: SO4, A1L97, CU, NA

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	0.07	0/1574	0.25	0/2128
1	B	0.08	0/1544	0.26	0/2088
1	C	0.10	0/1544	0.24	0/2088
1	D	0.09	0/1574	0.25	0/2128
All	All	0.09	0/6236	0.25	0/8432

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	1558	0	1461	17	0
1	B	1529	0	1432	16	0
1	C	1529	0	1432	12	0
1	D	1558	0	1461	16	0
2	A	1	0	0	0	0
2	B	1	0	0	0	0
2	C	1	0	0	0	0
2	D	1	0	0	0	0
3	B	1	0	0	0	0

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Mol	Chain	Non-H	H(model)	H(added)	Clashes	Symm-Clashes
3	C	1	0	0	0	0
4	C	5	0	0	0	0
5	A	41	0	0	0	0
5	B	46	0	0	0	0
5	C	45	0	0	0	0
5	D	35	0	0	0	0
All	All	6352	0	5786	58	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 5.

The worst 5 of 58 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:81:GLU:HG3	1:A:105:SER:HB3	1.76	0.68
1:B:17:ILE:HB	1:B:111:GLU:HB2	1.81	0.63
1:C:78:ILE:HD11	1:C:132:ASN:HB2	1.81	0.63
1:B:39:GLN:HG3	1:B:44:GLU:HG2	1.82	0.61
1:C:8:LYS:HD3	1:C:8:LYS:H	1.66	0.58

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	184/188 (98%)	173 (94%)	11 (6%)	0	100	100
1	B	180/188 (96%)	172 (96%)	8 (4%)	0	100	100
1	C	180/188 (96%)	171 (95%)	9 (5%)	0	100	100
1	D	184/188 (98%)	176 (96%)	8 (4%)	0	100	100
All	All	728/752 (97%)	692 (95%)	36 (5%)	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	167/167 (100%)	167 (100%)	0	100	100
1	B	164/167 (98%)	164 (100%)	0	100	100
1	C	164/167 (98%)	164 (100%)	0	100	100
1	D	167/167 (100%)	167 (100%)	0	100	100
All	All	662/668 (99%)	662 (100%)	0	100	100

There are no protein residues with a non-rotameric sidechain to report.

Sometimes sidechains can be flipped to improve hydrogen bonding and reduce clashes. 5 of 8 such sidechains are listed below:

Mol	Chain	Res	Type
1	C	174	ASN
1	C	120	HIS
1	B	120	HIS
1	A	174	ASN
1	C	49	GLN

### 5.3.3 RNA [i](#)

There are no RNA molecules in this entry.

## 5.4 Non-standard residues in protein, DNA, RNA chains [i](#)

4 non-standard protein/DNA/RNA residues 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	$\# Z  > 2$
1	A1L97	C	79	1,2	23,24,25	1.17	3 (13%)	27,32,34	1.70	8 (29%)
1	A1L97	D	79	1,2	23,24,25	1.19	3 (13%)	27,32,34	1.65	8 (29%)
1	A1L97	A	79	1,2	23,24,25	1.19	3 (13%)	27,32,34	1.66	8 (29%)
1	A1L97	B	79	1,2	23,24,25	1.19	3 (13%)	27,32,34	1.65	8 (29%)

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
1	A1L97	C	79	1,2	-	6/13/14/16	0/3/3/3
1	A1L97	D	79	1,2	-	6/13/14/16	0/3/3/3
1	A1L97	A	79	1,2	-	6/13/14/16	0/3/3/3
1	A1L97	B	79	1,2	-	6/13/14/16	0/3/3/3

The worst 5 of 12 bond length outliers are listed below:

Mol	Chain	Res	Type	Atoms	Z	Observed(Å)	Ideal(Å)
1	A	79	A1L97	C15-C13	2.70	1.53	1.47
1	B	79	A1L97	C15-C13	2.69	1.53	1.47
1	D	79	A1L97	C15-C13	2.68	1.53	1.47
1	C	79	A1L97	C15-C13	2.65	1.53	1.47
1	D	79	A1L97	C13-N12	-2.38	1.32	1.36

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

Mol	Chain	Res	Type	Atoms	Z	Observed(°)	Ideal(°)
1	C	79	A1L97	CZ-N07-N11	4.07	126.67	120.28
1	B	79	A1L97	CZ-N07-N11	3.87	126.36	120.28
1	A	79	A1L97	CZ-N07-N11	3.86	126.34	120.28
1	D	79	A1L97	CZ-N07-N11	3.84	126.31	120.28
1	C	79	A1L97	C15-C13-N12	2.87	126.20	122.31

There are no chirality outliers.

5 of 24 torsion outliers are listed below:

Mol	Chain	Res	Type	Atoms
1	A	79	A1L97	C-CA-CB-CG
1	B	79	A1L97	C-CA-CB-CG
1	B	79	A1L97	N-CA-CB-CG
1	C	79	A1L97	C-CA-CB-CG
1	D	79	A1L97	C-CA-CB-CG

There are no ring outliers.

No monomer is involved in short contacts.

## 5.5 Carbohydrates [i](#)

There are no oligosaccharides in this entry.

## 5.6 Ligand geometry [i](#)

Of 7 ligands modelled in this entry, 6 are monoatomic - leaving 1 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	SO4	C	203	-	4,4,4	0.67	0	6,6,6	0.07	0

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 ⓘ

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	186/188 (98%)	-1.65	0 100 100	25, 35, 53, 61	0
1	B	182/188 (96%)	-1.68	0 100 100	22, 37, 54, 73	0
1	C	182/188 (96%)	-1.67	0 100 100	24, 36, 54, 71	0
1	D	186/188 (98%)	-1.66	0 100 100	23, 36, 54, 68	0
All	All	736/752 (97%)	-1.67	0 100 100	22, 36, 54, 73	0

There are no RSRZ outliers to report.

### 6.2 Non-standard residues in protein, DNA, RNA chains [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
1	A1L97	A	79	22/23	0.99	0.05	32,67,99,108	0
1	A1L97	B	79	22/23	0.99	0.05	29,68,96,97	0
1	A1L97	C	79	22/23	0.99	0.06	31,71,93,96	0
1	A1L97	D	79	22/23	0.99	0.04	35,73,91,94	0

### 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	CU	B	201	1/1	0.97	0.05	118,118,118,118	0
2	CU	A	201	1/1	0.98	0.03	111,111,111,111	0
4	SO4	C	203	5/5	0.98	0.03	55,58,69,87	0
2	CU	D	201	1/1	0.99	0.02	107,107,107,107	0
3	NA	B	202	1/1	0.99	0.04	23,23,23,23	0
3	NA	C	202	1/1	0.99	0.05	22,22,22,22	0
2	CU	C	201	1/1	0.99	0.03	122,122,122,122	0

## 6.5 Other polymers [i](#)

There are no such residues in this entry.