



Full wwPDB X-ray Structure Validation Report ⓘ

Mar 6, 2026 – 01:51 AM UTC

PDB ID : 7QA1 / pdb_00007qa1
Title : The structure of natural crystals of the Lysinibacillus sphaericus Tpp49Aa1
pesticidal protein elucidated using serial femtosecond crystallography at an
X-ray free electron laser
Authors : Williamson, L.J.; Rizkallah, P.J.; Berry, C.; Oberthur, D.; Galchenkova, M.;
Yefanov, O.; Bean, R.; Best, H.L.
Deposited on : 2021-11-15
Resolution : 2.20 Å(reported)

This is a Full wwPDB X-ray Structure Validation 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
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

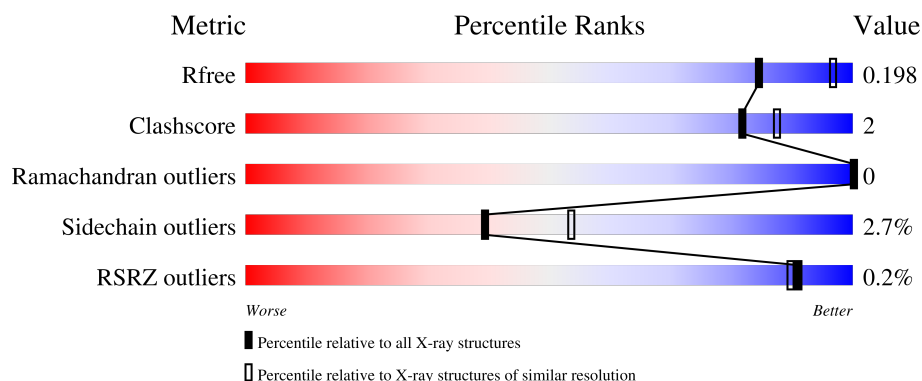
1 Overall quality at a glance

The following experimental techniques were used to determine the structure:

X-RAY DIFFRACTION

The reported resolution of this entry is 2.20 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	6164 (2.20-2.20)
Clashscore	190562	6851 (2.20-2.20)
Ramachandran outliers	187476	6768 (2.20-2.20)
Sidechain outliers	187428	6769 (2.20-2.20)
RSRZ outliers	180081	6166 (2.20-2.20)

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	416	 91% 7% •
1	B	416	 89% 10% •

2 Entry composition

There are 2 unique types of molecules in this entry. The entry contains 7204 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 Toxin-10 pesticidal protein (Tpp) 49Aa1.

Mol	Chain	Residues	Atoms					ZeroOcc	AltConf	Trace
1	A	416	Total	C	N	O	S	0	2	0
			3391	2131	612	638	10			
1	B	416	Total	C	N	O	S	0	9	0
			3443	2161	627	645	10			

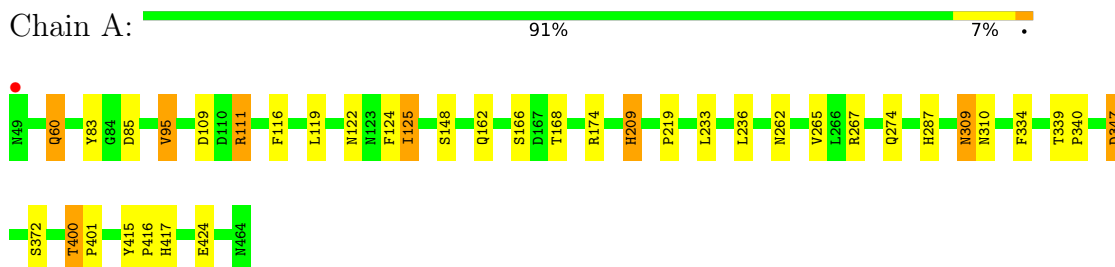
- Molecule 2 is water.

Mol	Chain	Residues	Atoms		ZeroOcc	AltConf
2	A	187	Total	O	0	0
			187	187		
2	B	183	Total	O	0	0
			183	183		

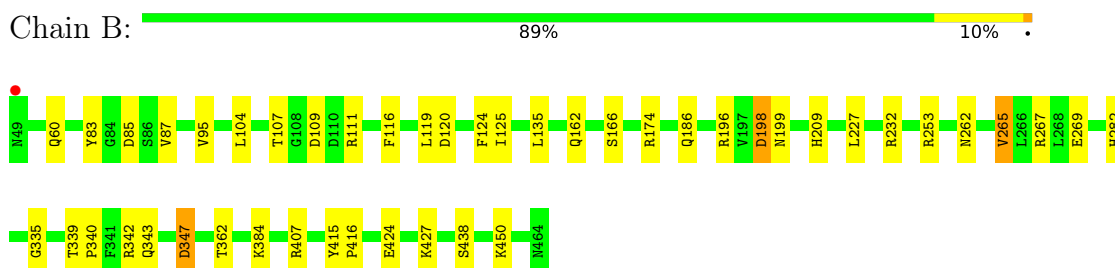
3 Residue-property plots [i](#)

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: Toxin-10 pesticidal protein (Tpp) 49Aa1



- Molecule 1: Toxin-10 pesticidal protein (Tpp) 49Aa1



4 Data and refinement statistics

Property	Value	Source
Space group	P 21 21 21	Depositor
Cell constants a, b, c, α , β , γ	79.76Å 83.15Å 157.33Å 90.00° 90.00° 90.00°	Depositor
Resolution (Å)	28.57 – 2.20 28.57 – 2.20	Depositor EDS
% Data completeness (in resolution range)	99.9 (28.57-2.20) 91.2 (28.57-2.20)	Depositor EDS
R_{merge}	(Not available)	Depositor
R_{sym}	(Not available)	Depositor
$\langle I/\sigma(I) \rangle$ ¹	1.24 (at 2.20Å)	Xtriage
Refinement program	REFMAC 5.8.0267, PHENIX 1.19-4092-000	Depositor
R, R_{free}	0.160 , 0.197 0.167 , 0.198	Depositor DCC
R_{free} test set	1755 reflections (3.26%)	wwPDB-VP
Wilson B-factor (Å ²)	20.5	Xtriage
Anisotropy	0.422	Xtriage
Bulk solvent k_{sol} (e/Å ³), B_{sol} (Å ²)	0.28 , 33.3	EDS
L-test for twinning ²	$\langle L \rangle = 0.48$, $\langle L^2 \rangle = 0.30$	Xtriage
Estimated twinning fraction	0.148 for k,h,-l	Xtriage
F_o, F_c correlation	0.96	EDS
Total number of atoms	7204	wwPDB-VP
Average B, all atoms (Å ²)	33.0	wwPDB-VP

Xtriage's analysis on translational NCS is as follows: *The largest off-origin peak in the Patterson function is 3.86% 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

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	1.15	4/3470 (0.1%)	1.37	15/4716 (0.3%)
1	B	1.12	3/3535 (0.1%)	1.35	10/4803 (0.2%)
All	All	1.13	7/7005 (0.1%)	1.36	25/9519 (0.3%)

All (7) bond length outliers are listed below:

Mol	Chain	Res	Type	Atoms	Z	Observed(Å)	Ideal(Å)
1	A	347	ASP	C-O	-6.79	1.16	1.24
1	B	269	GLU	CD-OE1	6.43	1.37	1.25
1	A	209	HIS	CE1-NE2	5.79	1.38	1.32
1	B	282	HIS	CE1-NE2	5.68	1.38	1.32
1	A	148	SER	C-O	5.47	1.30	1.24
1	B	347	ASP	C-O	-5.44	1.17	1.24
1	A	287	HIS	CE1-NE2	5.13	1.37	1.32

All (25) bond angle outliers are listed below:

Mol	Chain	Res	Type	Atoms	Z	Observed(°)	Ideal(°)
1	B	198	ASP	CB-CA-C	9.83	126.15	109.53
1	A	309	ASN	CB-CA-C	8.06	123.93	109.83
1	A	424	GLU	CB-CA-C	-8.04	97.17	110.85
1	B	424	GLU	CB-CA-C	-7.14	98.71	110.85
1	A	310	ASN	CA-CB-CG	-7.05	105.55	112.60
1	B	162	GLN	CB-CA-C	6.61	122.34	111.23
1	A	262	ASN	CB-CA-C	6.55	121.95	112.12
1	A	168	THR	CA-CB-OG1	-6.38	100.03	109.60
1	A	95	VAL	CB-CA-C	6.37	117.00	110.70
1	A	162	GLN	CB-CA-C	6.36	121.91	111.23
1	B	83	TYR	CA-C-N	6.29	127.10	119.99
1	B	83	TYR	C-N-CA	6.29	127.10	119.99
1	A	83	TYR	CA-C-N	6.09	126.88	119.99
1	A	83	TYR	C-N-CA	6.09	126.88	119.99
1	A	400	THR	CB-CA-C	6.08	118.19	109.26

Continued on next page...

Continued from previous page...

Mol	Chain	Res	Type	Atoms	Z	Observed(°)	Ideal(°)
1	A	274	GLN	CB-CG-CD	-5.70	102.91	112.60
1	A	334	PHE	CA-C-O	-5.68	114.57	120.70
1	B	262	ASN	CB-CA-C	5.55	120.44	112.12
1	A	111	ARG	CG-CD-NE	-5.38	100.18	112.00
1	A	85	ASP	CA-CB-CG	5.34	117.94	112.60
1	B	120	ASP	CA-CB-CG	5.17	117.78	112.60
1	B	85	ASP	CA-CB-CG	5.10	117.70	112.60
1	B	335	GLY	CA-C-N	5.09	127.61	120.28
1	B	335	GLY	C-N-CA	5.09	127.61	120.28
1	A	400	THR	CA-CB-OG1	-5.07	102.00	109.60

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	3391	0	3286	13	0
1	B	3443	0	3339	21	0
2	A	187	0	0	2	0
2	B	183	0	0	7	0
All	All	7204	0	6625	33	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 2.

All (33) 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:267:ARG:NH1	2:B:501:HOH:O	2.26	0.68
1:B:87:VAL:H	1:B:186:GLN:HE22	1.50	0.59
1:B:209:HIS:HE1	2:B:563:HOH:O	1.86	0.58
1:A:219:PRO:HD3	2:A:529:HOH:O	2.04	0.57
1:B:109:ASP:OD1	1:B:111:ARG:HG3	2.05	0.57
1:A:119:LEU:HD11	1:A:125:ILE:HD12	1.86	0.56

Continued on next page...

Continued from previous page...

Atom-1	Atom-2	Interatomic distance (Å)	Clash overlap (Å)
1:A:109:ASP:OD1	1:A:111:ARG:HG3	2.06	0.56
1:A:122:ASN:HA	2:A:640:HOH:O	2.08	0.54
1:B:196:ARG:HH12	1:B:198:ASP:HB3	1.72	0.53
1:B:415:TYR:HA	1:B:416:PRO:C	2.34	0.51
1:A:415:TYR:HA	1:A:416:PRO:C	2.34	0.51
1:B:232:ARG:HH11	1:B:232:ARG:HG2	1.77	0.50
1:A:233:LEU:O	1:A:417:HIS:HE1	1.95	0.48
1:B:407[B]:ARG:NH2	1:B:438:SER:O	2.48	0.47
1:B:267:ARG:CZ	2:B:501:HOH:O	2.59	0.46
1:B:342[B]:ARG:HG3	1:B:343:GLN:N	2.31	0.46
1:A:339:THR:N	1:A:340:PRO:CD	2.79	0.46
1:B:362:THR:HG22	2:B:556:HOH:O	2.15	0.46
1:A:267:ARG:HD3	1:A:267:ARG:HA	1.81	0.44
1:B:265:VAL:HA	2:B:501:HOH:O	2.16	0.44
1:B:339:THR:N	1:B:340:PRO:CD	2.81	0.44
1:A:119:LEU:HD21	1:A:125:ILE:HD13	2.00	0.44
1:A:400:THR:HA	1:A:401:PRO:HD3	1.90	0.43
1:A:60:GLN:HG3	1:A:209:HIS:CE1	2.54	0.43
1:A:347:ASP:OD2	1:B:347:ASP:OD2	2.37	0.42
1:B:232:ARG:HG2	1:B:232:ARG:NH1	2.35	0.42
1:A:116:PHE:HB3	1:A:124:PHE:CD1	2.55	0.42
1:B:116:PHE:HB3	1:B:124:PHE:CD1	2.54	0.42
1:B:209:HIS:CE1	2:B:563:HOH:O	2.68	0.41
1:B:119:LEU:HD21	1:B:125:ILE:HG12	2.03	0.41
1:B:227:LEU:CD2	1:B:384:LYS:HE2	2.51	0.41
1:B:267:ARG:NH2	2:B:501:HOH:O	2.54	0.41
1:B:450:LYS:HD3	1:B:450:LYS:HA	1.83	0.40

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	416/416 (100%)	408 (98%)	8 (2%)	0	100	100
1	B	423/416 (102%)	416 (98%)	7 (2%)	0	100	100
All	All	839/832 (101%)	824 (98%)	15 (2%)	0	100	100

There are no Ramachandran outliers to report.

5.3.2 Protein sidechains ⓘ

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	373/371 (100%)	364 (98%)	9 (2%)	43	58
1	B	380/371 (102%)	369 (97%)	11 (3%)	37	51
All	All	753/742 (102%)	733 (97%)	20 (3%)	39	53

All (20) residues with a non-rotameric sidechain are listed below:

Mol	Chain	Res	Type
1	A	60	GLN
1	A	95	VAL
1	A	125	ILE
1	A	166	SER
1	A	174	ARG
1	A	236	LEU
1	A	265	VAL
1	A	309	ASN
1	A	372	SER
1	B	60	GLN
1	B	95	VAL
1	B	104	LEU
1	B	107	THR
1	B	135	LEU
1	B	166	SER
1	B	174	ARG
1	B	199	ASN
1	B	253	ARG

Continued on next page...

Continued from previous page...

Mol	Chain	Res	Type
1	B	265	VAL
1	B	427	LYS

Sometimes sidechains can be flipped to improve hydrogen bonding and reduce clashes. All (16) such sidechains are listed below:

Mol	Chain	Res	Type
1	A	51	ASN
1	A	66	HIS
1	A	68	ASN
1	A	69	ASN
1	A	162	GLN
1	A	199	ASN
1	A	284	GLN
1	A	310	ASN
1	A	336	ASN
1	A	417	HIS
1	A	418	ASN
1	B	66	HIS
1	B	162	GLN
1	B	186	GLN
1	B	199	ASN
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 ⓘ

There are no ligands in this entry.

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	416/416 (100%)	-0.47	1 (0%) 91 90	11, 31, 63, 93	2 (0%)
1	B	416/416 (100%)	-0.48	1 (0%) 91 90	8, 30, 60, 87	9 (2%)
All	All	832/832 (100%)	-0.47	2 (0%) 91 90	8, 31, 62, 93	11 (1%)

All (2) RSRZ outliers are listed below:

Mol	Chain	Res	Type	RSRZ
1	B	49	ASN	2.9
1	A	49	ASN	2.9

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](#)

There are no ligands in this entry.

6.5 Other polymers [i](#)

There are no such residues in this entry.