



wwPDB X-ray Structure Validation Summary Report ⓘ

Mar 5, 2026 – 10:02 AM UTC

PDB ID : 1K23 / pdb_00001k23
Title : Inorganic Pyrophosphatase (Family II) from *Bacillus subtilis*
Authors : Ahn, S.; Milner, A.J.; Futterer, K.; Konopka, M.; Ilias, M.; Young, T.W.;
White, S.A.
Deposited on : 2001-09-26
Resolution : 3.00 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)	:	NOT EXECUTED
EDS	:	NOT EXECUTED
Percentile statistics	:	20250101.v01 (using entries in the PDB archive January 1st 2025)
Ideal geometry (proteins)	:	Engh & Huber (2001)
Ideal geometry (DNA, RNA)	:	Parkinson et al. (1996)
Validation Pipeline (wwPDB-VP)	:	2.49

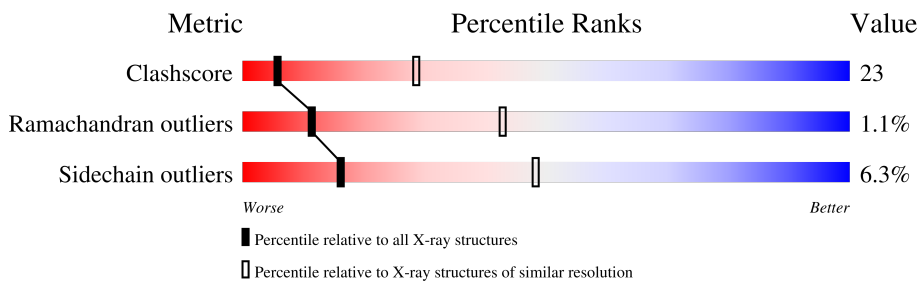
1 Overall quality at a glance

The following experimental techniques were used to determine the structure:

X-RAY DIFFRACTION

The reported resolution of this entry is 3.00 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))
Clashscore	190562	2977 (3.00-3.00)
Ramachandran outliers	187476	2877 (3.00-3.00)
Sidechain outliers	187428	2880 (3.00-3.00)

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 $\leq 5\%$.

Note EDS was not executed.

Mol	Chain	Length	Quality of chain
1	A	309	
1	B	309	
1	C	309	
1	D	309	

2 Entry composition

There are 3 unique types of molecules in this entry. The entry contains 8973 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 Manganese-dependent inorganic pyrophosphatase.

Mol	Chain	Residues	Atoms						ZeroOcc	AltConf	Trace
1	A	307	Total	C	N	O	S	Se	0	0	0
			2371	1496	392	475	3	5			
1	B	307	Total	C	N	O	S	Se	0	0	0
			2371	1496	392	475	3	5			
1	C	308	Total	C	N	O	S	Se	0	0	0
			2376	1499	393	476	3	5			
1	D	231	Total	C	N	O	S	Se	0	0	0
			1789	1123	296	362	3	5			

There are 20 discrepancies between the modelled and reference sequences:

Chain	Residue	Modelled	Actual	Comment	Reference
A	1	MSE	MET	modified residue	UNP P37487
A	126	MSE	MET	modified residue	UNP P37487
A	142	MSE	MET	modified residue	UNP P37487
A	184	MSE	MET	modified residue	UNP P37487
A	307	MSE	MET	modified residue	UNP P37487
B	1	MSE	MET	modified residue	UNP P37487
B	126	MSE	MET	modified residue	UNP P37487
B	142	MSE	MET	modified residue	UNP P37487
B	184	MSE	MET	modified residue	UNP P37487
B	307	MSE	MET	modified residue	UNP P37487
C	1	MSE	MET	modified residue	UNP P37487
C	126	MSE	MET	modified residue	UNP P37487
C	142	MSE	MET	modified residue	UNP P37487
C	184	MSE	MET	modified residue	UNP P37487
C	307	MSE	MET	modified residue	UNP P37487
D	1	MSE	MET	modified residue	UNP P37487
D	126	MSE	MET	modified residue	UNP P37487
D	142	MSE	MET	modified residue	UNP P37487
D	184	MSE	MET	modified residue	UNP P37487
D	307	MSE	MET	modified residue	UNP P37487

- Molecule 2 is MANGANESE (II) ION (CCD ID: MN) (formula: Mn).

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

- Molecule 3 is water.

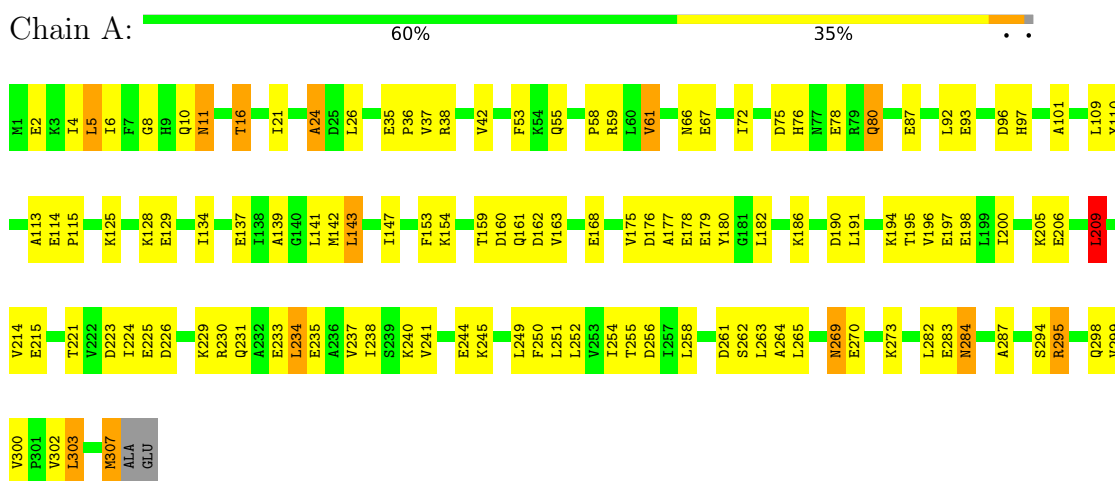
Mol	Chain	Residues	Atoms		ZeroOcc	AltConf
3	A	24	Total 24	O 24	0	0
3	B	9	Total 9	O 9	0	0
3	C	13	Total 13	O 13	0	0
3	D	12	Total 12	O 12	0	0

3 Residue-property plots

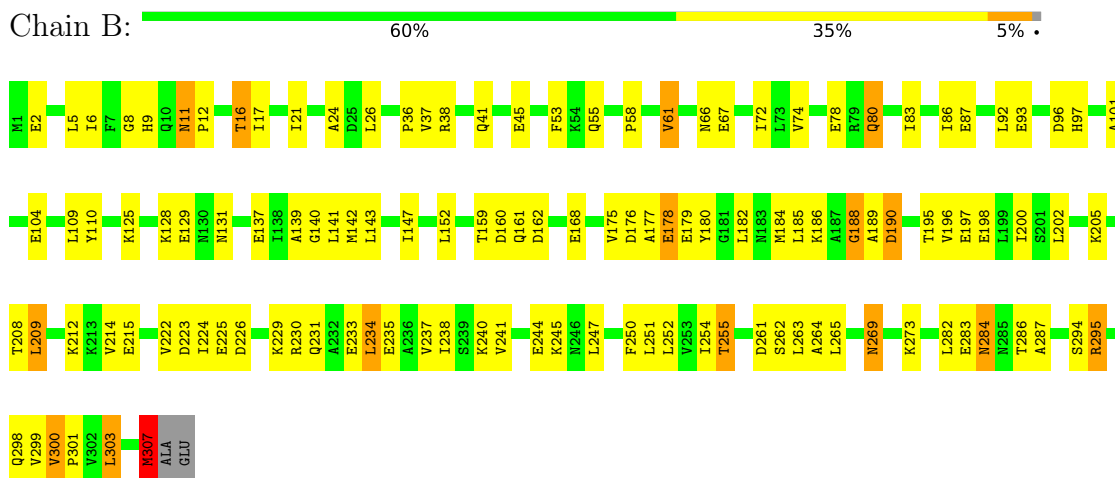
These plots are drawn for all protein, RNA, DNA and oligosaccharide chains in the entry. The first graphic for a chain summarises the proportions of the various outlier classes displayed in the second graphic. The second graphic shows the sequence view annotated by issues in geometry. Residues are color-coded 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. 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.

Note EDS was not executed.

- Molecule 1: Manganese-dependent inorganic pyrophosphatase

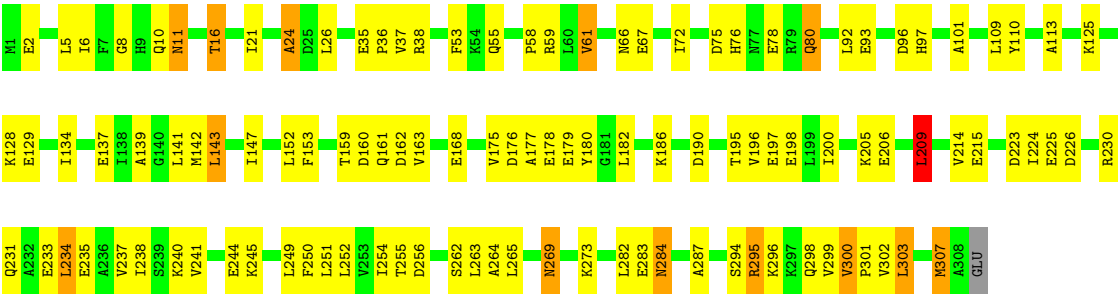


- Molecule 1: Manganese-dependent inorganic pyrophosphatase

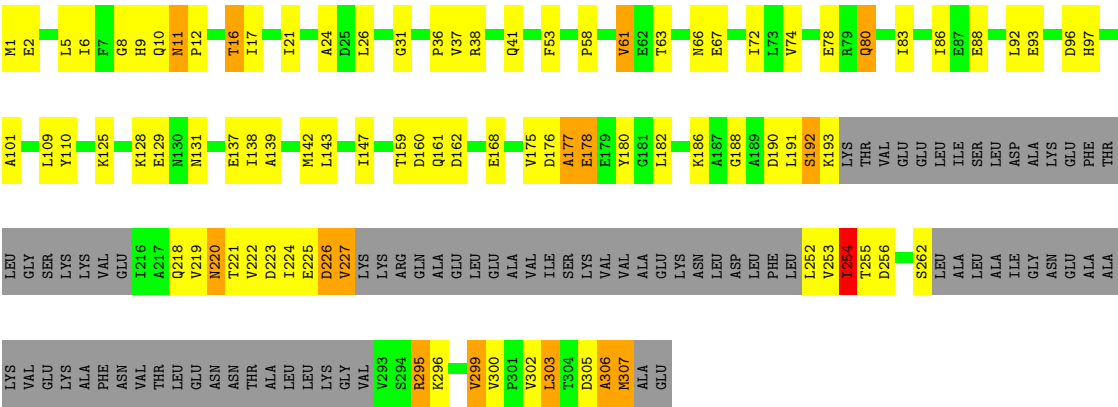


- Molecule 1: Manganese-dependent inorganic pyrophosphatase





● Molecule 1: Manganese-dependent inorganic pyrophosphatase



4 Data and refinement statistics

Xtriage (Phenix) and EDS were not executed - this section is therefore incomplete.

Property	Value	Source
Space group	P 21 21 21	Depositor
Cell constants a, b, c, α , β , γ	80.29Å 130.56Å 150.47Å 90.00° 90.00° 90.00°	Depositor
Resolution (Å)	19.96 – 3.00	Depositor
% Data completeness (in resolution range)	97.9 (19.96-3.00)	Depositor
R_{merge}	(Not available)	Depositor
R_{sym}	0.04	Depositor
Refinement program	CNS 1.1	Depositor
R, R_{free}	0.260 , 0.293	Depositor
Estimated twinning fraction	No twinning to report.	Xtriage
Total number of atoms	8973	wwPDB-VP
Average B, all atoms (Å ²)	60.0	wwPDB-VP

5 Model quality ⓘ

5.1 Standard geometry ⓘ

Bond lengths and bond angles in the following residue types are not validated in this section: MN

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	0.62	2/2392 (0.1%)	0.95	5/3230 (0.2%)
1	B	0.57	2/2392 (0.1%)	0.95	5/3230 (0.2%)
1	C	0.59	0/2397	0.95	5/3237 (0.2%)
1	D	0.68	2/1804 (0.1%)	0.96	6/2435 (0.2%)
All	All	0.61	6/8985 (0.1%)	0.95	21/12132 (0.2%)

The worst 5 of 6 bond length outliers are listed below:

Mol	Chain	Res	Type	Atoms	Z	Observed(Å)	Ideal(Å)
1	D	307	MSE	CG-SE	9.92	2.25	1.95
1	D	307	MSE	SE-CE	9.19	2.23	1.95
1	A	307	MSE	CG-SE	8.06	2.19	1.95
1	B	307	MSE	CG-SE	7.14	2.16	1.95
1	A	307	MSE	SE-CE	6.61	2.15	1.95

The worst 5 of 21 bond angle outliers are listed below:

Mol	Chain	Res	Type	Atoms	Z	Observed(°)	Ideal(°)
1	D	299	VAL	N-CA-C	6.99	118.59	110.62
1	B	300	VAL	CB-CA-C	-6.32	107.65	114.35
1	C	300	VAL	CB-CA-C	-6.11	107.88	114.35
1	C	209	LEU	N-CA-C	5.47	117.15	108.67
1	A	209	LEU	N-CA-C	5.46	117.13	108.67

There are no chirality outliers.

There are no planarity outliers.

5.2 Too-close contacts

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	2371	0	2420	105	0
1	B	2371	0	2420	131	0
1	C	2376	0	2425	90	0
1	D	1789	0	1789	97	0
2	A	2	0	0	0	0
2	B	2	0	0	0	0
2	C	2	0	0	0	0
2	D	2	0	0	0	0
3	A	24	0	0	4	0
3	B	9	0	0	9	0
3	C	13	0	0	2	0
3	D	12	0	0	3	0
All	All	8973	0	9054	417	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 23.

The worst 5 of 417 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:307:MSE:SE	1:A:307:MSE:CE	2.15	1.45
1:B:307:MSE:SE	1:B:307:MSE:CG	2.16	1.43
1:B:307:MSE:SE	1:B:307:MSE:CE	2.15	1.43
1:A:307:MSE:SE	1:A:307:MSE:CG	2.19	1.41
1:D:307:MSE:SE	1:D:307:MSE:CE	2.23	1.37

There are no symmetry-related clashes.

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	305/309 (99%)	284 (93%)	19 (6%)	2 (1%)	18	53
1	B	305/309 (99%)	281 (92%)	19 (6%)	5 (2%)	7	34
1	C	306/309 (99%)	283 (92%)	21 (7%)	2 (1%)	18	53
1	D	223/309 (72%)	197 (88%)	22 (10%)	4 (2%)	6	31
All	All	1139/1236 (92%)	1045 (92%)	81 (7%)	13 (1%)	11	43

5 of 13 Ramachandran outliers are listed below:

Mol	Chain	Res	Type
1	B	202	LEU
1	B	190	ASP
1	D	192	SER
1	D	226	ASP
1	D	254	ILE

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	261/257 (102%)	246 (94%)	15 (6%)	18	52
1	B	261/257 (102%)	246 (94%)	15 (6%)	18	52
1	C	261/257 (102%)	245 (94%)	16 (6%)	17	49
1	D	198/257 (77%)	182 (92%)	16 (8%)	11	38
All	All	981/1028 (95%)	919 (94%)	62 (6%)	16	48

5 of 62 residues with a non-rotameric sidechain are listed below:

Mol	Chain	Res	Type
1	B	303	LEU
1	D	190	ASP
1	C	80	GLN

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Mol	Chain	Res	Type
1	D	178	GLU
1	D	295	ARG

Sometimes sidechains can be flipped to improve hydrogen bonding and reduce clashes. 5 of 23 such sidechains are listed below:

Mol	Chain	Res	Type
1	C	69	ASN
1	C	269	ASN
1	C	218	GLN
1	D	33	ASN
1	B	47	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](#)

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 8 ligands modelled in this entry, 8 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](#)

EDS was not executed - this section is therefore empty.

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

EDS was not executed - this section is therefore empty.

6.3 Carbohydrates [i](#)

EDS was not executed - this section is therefore empty.

6.4 Ligands [i](#)

EDS was not executed - this section is therefore empty.

6.5 Other polymers [i](#)

EDS was not executed - this section is therefore empty.