



Full wwPDB X-ray Structure Validation Report ⓘ

Mar 8, 2026 – 06:03 AM UTC

PDB ID : 4IMH / pdb_00004imh
Title : Crystal Structure of Cytoplasmic Heme Binding Protein, PhuS, from *Pseudomonas aeruginosa*
Authors : Tripathi, S.M.; Poulos, T.L.
Deposited on : 2013-01-02
Resolution : 1.98 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

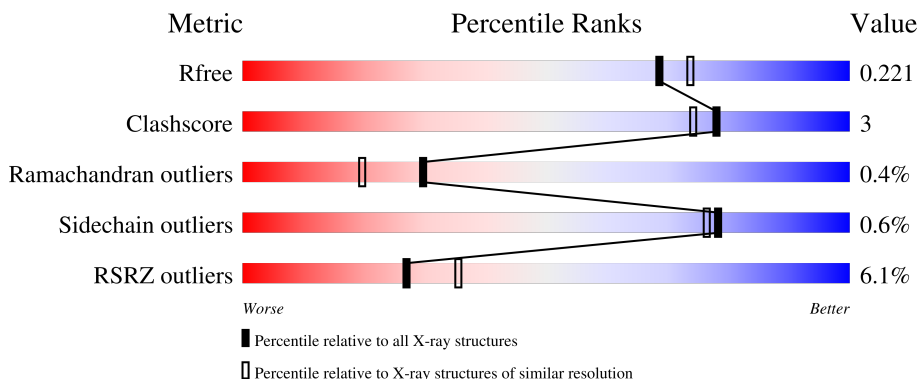
1 Overall quality at a glance

The following experimental techniques were used to determine the structure:

X-RAY DIFFRACTION

The reported resolution of this entry is 1.98 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	1506 (1.98-1.98)
Clashscore	190562	1534 (1.98-1.98)
Ramachandran outliers	187476	1518 (1.98-1.98)
Sidechain outliers	187428	1518 (1.98-1.98)
RSRZ outliers	180081	1506 (1.98-1.98)

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	360	5% 89% 7% .
1	B	360	6% 88% 8% ..

2 Entry composition

There are 2 unique types of molecules in this entry. The entry contains 11103 atoms, of which 5279 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 Hemin degrading factor.

Mol	Chain	Residues	Atoms						ZeroOcc	AltConf	Trace
1	A	347	Total	C	H	N	O	S	0	3	0
			5388	1731	2649	503	499	6			
1	B	347	Total	C	H	N	O	S	0	1	0
			5344	1718	2630	494	495	7			

There are 12 discrepancies between the modelled and reference sequences:

Chain	Residue	Modelled	Actual	Comment	Reference
A	355	HIS	-	expression tag	UNP O68880
A	356	HIS	-	expression tag	UNP O68880
A	357	HIS	-	expression tag	UNP O68880
A	358	HIS	-	expression tag	UNP O68880
A	359	HIS	-	expression tag	UNP O68880
A	360	HIS	-	expression tag	UNP O68880
B	355	HIS	-	expression tag	UNP O68880
B	356	HIS	-	expression tag	UNP O68880
B	357	HIS	-	expression tag	UNP O68880
B	358	HIS	-	expression tag	UNP O68880
B	359	HIS	-	expression tag	UNP O68880
B	360	HIS	-	expression tag	UNP O68880

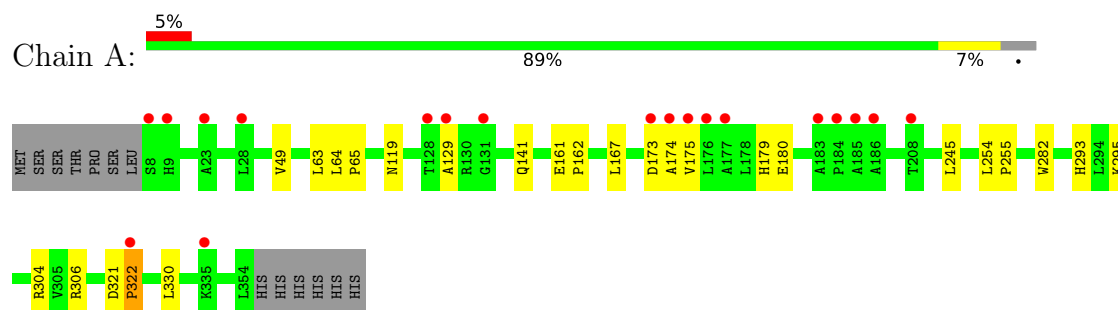
- Molecule 2 is water.

Mol	Chain	Residues	Atoms		ZeroOcc	AltConf
2	A	216	Total	O	0	0
			216	216		
2	B	155	Total	O	0	0
			155	155		

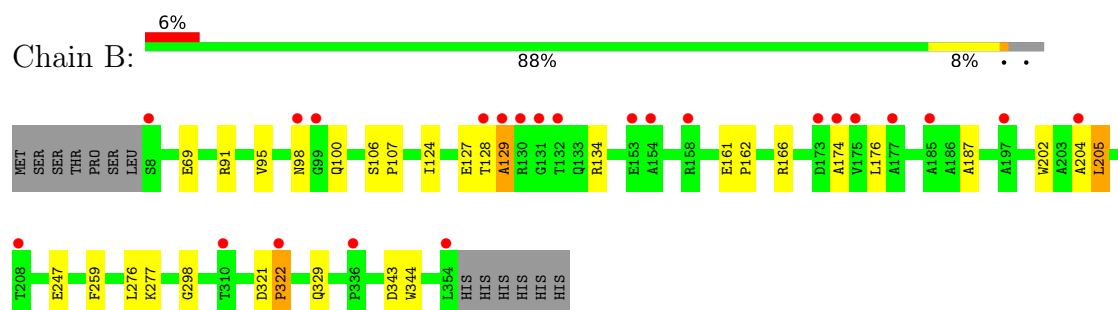
3 Residue-property plots

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 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: Hemin degrading factor



- Molecule 1: Hemin degrading factor



4 Data and refinement statistics

Property	Value	Source
Space group	I 4	Depositor
Cell constants a, b, c, α , β , γ	187.73Å 187.73Å 42.44Å 90.00° 90.00° 90.00°	Depositor
Resolution (Å)	41.98 – 1.98 41.98 – 1.98	Depositor EDS
% Data completeness (in resolution range)	98.7 (41.98-1.98) 98.6 (41.98-1.98)	Depositor EDS
R_{merge}	0.06	Depositor
R_{sym}	(Not available)	Depositor
$\langle I/\sigma(I) \rangle$ ¹	4.20 (at 1.98Å)	Xtriage
Refinement program	PHENIX (phenix.refine: 1.8.1_1168)	Depositor
R, R_{free}	0.175 , 0.222 0.177 , 0.221	Depositor DCC
R_{free} test set	2644 reflections (5.03%)	wwPDB-VP
Wilson B-factor (Å ²)	29.3	Xtriage
Anisotropy	0.533	Xtriage
Bulk solvent k_{sol} (e/Å ³), B_{sol} (Å ²)	0.42 , 53.6	EDS
L-test for twinning ²	$\langle L \rangle = 0.49$, $\langle L^2 \rangle = 0.33$	Xtriage
Estimated twinning fraction	0.015 for -k,-h,-l	Xtriage
F_o, F_c correlation	0.96	EDS
Total number of atoms	11103	wwPDB-VP
Average B, all atoms (Å ²)	48.0	wwPDB-VP

Xtriage's analysis on translational NCS is as follows: *The largest off-origin peak in the Patterson function is 5.22% 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](#)

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	0.82	0/2804	0.91	5/3814 (0.1%)
1	B	0.71	0/2778	0.95	10/3779 (0.3%)
All	All	0.76	0/5582	0.93	15/7593 (0.2%)

There are no bond length outliers.

All (15) bond angle outliers are listed below:

Mol	Chain	Res	Type	Atoms	Z	Observed(°)	Ideal(°)
1	B	176	LEU	CA-C-N	11.38	138.23	121.72
1	B	176	LEU	C-N-CA	11.38	138.23	121.72
1	A	179	HIS	CA-C-N	10.46	134.94	120.39
1	A	179	HIS	C-N-CA	10.46	134.94	120.39
1	B	204	ALA	CA-C-N	10.44	135.62	120.90
1	B	204	ALA	C-N-CA	10.44	135.62	120.90
1	B	95	VAL	CA-C-N	8.73	135.62	120.87
1	B	95	VAL	C-N-CA	8.73	135.62	120.87
1	B	100	GLN	N-CA-C	8.35	123.66	113.38
1	B	127	GLU	CA-C-N	8.01	136.87	122.46
1	B	127	GLU	C-N-CA	8.01	136.87	122.46
1	A	321	ASP	CA-C-N	-6.49	113.25	120.45
1	A	321	ASP	C-N-CA	-6.49	113.25	120.45
1	A	180	GLU	N-CA-C	-5.35	102.85	109.64
1	B	98	ASN	N-CA-C	-5.12	103.84	110.19

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	2739	2649	2691	14	0
1	B	2714	2630	2670	17	0
2	A	216	0	0	2	0
2	B	155	0	0	5	0
All	All	5824	5279	5361	30	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 3.

All (30) 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:322:PRO:HD3	2:B:553:HOH:O	1.78	0.82
1:A:322:PRO:HD3	2:A:615:HOH:O	1.79	0.82
1:B:298:GLY:O	2:B:553:HOH:O	2.07	0.71
1:B:259:PHE:HB2	1:B:329:GLN:HG2	1.86	0.58
1:B:259:PHE:HB2	1:B:329:GLN:CG	2.35	0.56
1:A:322:PRO:CD	2:A:615:HOH:O	2.47	0.52
1:B:128:THR:HG23	1:B:129:ALA:N	2.25	0.51
1:B:161:GLU:HB2	1:B:162:PRO:HD3	1.94	0.49
1:B:69:GLU:OE1	1:B:166:ARG:NH2	2.45	0.49
1:B:91:ARG:NH1	2:B:524:HOH:O	2.47	0.47
1:A:282:TRP:CE2	1:A:295:LYS:HE3	2.50	0.46
1:B:202:TRP:O	1:B:205:LEU:HB2	2.16	0.45
1:A:304:ARG:HD3	1:A:306:ARG:NH2	2.33	0.44
1:B:321:ASP:HB2	1:B:322:PRO:HD2	1.99	0.43
1:A:245:LEU:HD22	1:A:330:LEU:HD12	1.98	0.43
1:A:161:GLU:HB2	1:A:162:PRO:HD3	2.01	0.43
1:B:124:ILE:O	1:B:134:ARG:HA	2.19	0.43
1:A:293:HIS:CE1	1:B:277:LYS:HE3	2.54	0.43
1:B:343:ASP:OD1	1:B:344:TRP:N	2.52	0.43
1:A:63:LEU:HD13	1:A:167:LEU:HD13	2.01	0.43
1:B:187:ALA:N	2:B:523:HOH:O	2.48	0.42
1:A:64:LEU:HB2	1:A:65:PRO:HD3	2.02	0.42
1:B:247:GLU:HA	1:B:276:LEU:CD1	2.50	0.41
1:A:49:VAL:HB	1:A:174:ALA:HB2	2.02	0.41
1:B:106:SER:HB2	1:B:107:PRO:HD2	2.02	0.41
1:A:119:ASN:ND2	1:A:141:GLN:OE1	2.53	0.41
1:A:173:ASP:CB	1:A:174:ALA:CA	2.98	0.41

Continued on next page...

Continued from previous page...

Atom-1	Atom-2	Interatomic distance (Å)	Clash overlap (Å)
1:A:129:ALA:HB3	2:B:555:HOH:O	2.20	0.41
1:B:259:PHE:HB2	1:B:329:GLN:HG3	2.03	0.40
1:A:254:LEU:HD12	1:A:255:PRO:HD2	2.03	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	348/360 (97%)	337 (97%)	10 (3%)	1 (0%)	36	27
1	B	346/360 (96%)	334 (96%)	10 (3%)	2 (1%)	21	12
All	All	694/720 (96%)	671 (97%)	20 (3%)	3 (0%)	30	20

All (3) Ramachandran outliers are listed below:

Mol	Chain	Res	Type
1	B	129	ALA
1	B	174	ALA
1	A	175	VAL

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.

Continued on next page...

Continued from previous page...

Mol	Chain	Analysed	Rotameric	Outliers	Percentiles	
1	A	275/285 (96%)	274 (100%)	1 (0%)	84	82
1	B	272/285 (95%)	270 (99%)	2 (1%)	76	73
All	All	547/570 (96%)	544 (100%)	3 (0%)	78	79

All (3) residues with a non-rotameric sidechain are listed below:

Mol	Chain	Res	Type
1	A	322	PRO
1	B	205	LEU
1	B	322	PRO

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	119	ASN
1	A	179	HIS
1	B	179	HIS
1	B	267	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

6.1 Protein, DNA and RNA chains

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	347/360 (96%)	0.07	19 (5%) 30 39	19, 39, 73, 106	3 (0%)
1	B	347/360 (96%)	0.46	23 (6%) 24 32	26, 52, 88, 121	1 (0%)
All	All	694/720 (96%)	0.27	42 (6%) 27 35	19, 44, 83, 121	4 (0%)

All (42) RSRZ outliers are listed below:

Mol	Chain	Res	Type	RSRZ
1	B	129	ALA	5.6
1	A	174	ALA	5.3
1	A	175	VAL	5.1
1	B	131	GLY	4.7
1	B	354	LEU	4.4
1	B	130	ARG	3.7
1	A	128	THR	3.3
1	B	177	ALA	3.3
1	B	99	GLY	3.3
1	A	208	THR	3.2
1	A	129	ALA	3.2
1	B	336	PRO	3.0
1	A	28	LEU	2.9
1	A	9	HIS	2.8
1	A	183	ALA	2.7
1	B	175	VAL	2.7
1	B	173	ASP	2.7
1	B	208	THR	2.7
1	B	197	ALA	2.7
1	B	8	SER	2.7
1	A	177	ALA	2.6
1	A	322	PRO	2.6
1	B	174	ALA	2.6
1	B	204	ALA	2.6

Continued on next page...

Continued from previous page...

Mol	Chain	Res	Type	RSRZ
1	A	335	LYS	2.6
1	A	131	GLY	2.5
1	B	322	PRO	2.5
1	A	8	SER	2.4
1	A	176	LEU	2.3
1	B	132	THR	2.3
1	A	23	ALA	2.3
1	B	158	ARG	2.3
1	A	173	ASP	2.3
1	A	185	ALA	2.2
1	B	185	ALA	2.2
1	B	154	ALA	2.2
1	B	310	THR	2.1
1	B	153	GLU	2.1
1	A	186	ALA	2.0
1	B	128	THR	2.0
1	B	98	ASN	2.0
1	A	184	PRO	2.0

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.