



Full wwPDB X-ray Structure Validation Report ⓘ

Mar 10, 2026 – 06:58 AM UTC

PDB ID : 1C4W / pdb_00001c4w
Title : 1.9 Å STRUCTURE OF A-THIOPHOSPHONATE MODIFIED CHEY D57C
Authors : Halkides, C.J.; McEvoy, M.M.; Matsumura, P.; Volz, K.; Dahlquist, F.W.
Deposited on : 1999-09-28
Resolution : 1.84 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
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

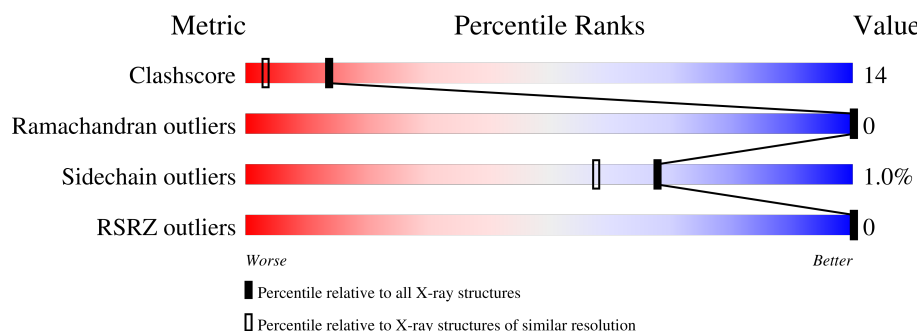
1 Overall quality at a glance

The following experimental techniques were used to determine the structure:

X-RAY DIFFRACTION

The reported resolution of this entry is 1.84 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	1329 (1.84-1.84)
Ramachandran outliers	187476	1318 (1.84-1.84)
Sidechain outliers	187428	1318 (1.84-1.84)
RSRZ outliers	180081	1296 (1.84-1.84)

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 ≥ 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	128	53% 36% 11%

2 Entry composition

There are 2 unique types of molecules in this entry. The entry contains 1131 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 CHEMOTAXIS PROTEIN CHEY.

Mol	Chain	Residues	Atoms						ZeroOcc	AltConf	Trace
1	A	128	Total	C	N	O	P	S	0	2	0
			991	625	163	193	2	8			

There is a discrepancy between the modelled and reference sequences:

Chain	Residue	Modelled	Actual	Comment	Reference
A	57	CYQ	ASP	engineered mutation	UNP P06143

- Molecule 2 is water.

Mol	Chain	Residues	Atoms		ZeroOcc	AltConf
2	A	140	Total	O	0	0
			140	140		

i

- Molecule 1: CHEMOTAXIS PROTEIN CHEY



4 Data and refinement statistics

Property	Value	Source
Space group	P 21 21 21	Depositor
Cell constants a, b, c, α , β , γ	45.62Å 47.74Å 53.13Å 90.00° 90.00° 90.00°	Depositor
Resolution (Å)	10.00 – 1.84 10.00 – 1.84	Depositor EDS
% Data completeness (in resolution range)	88.3 (10.00-1.84) 96.1 (10.00-1.84)	Depositor EDS
R_{merge}	0.07	Depositor
R_{sym}	(Not available)	Depositor
$\langle I/\sigma(I) \rangle$ ¹	3.17 (at 1.84Å)	Xtriage
Refinement program	PROTIN/PROFFT, PROTIN, PROFFT	Depositor
R, R_{free}	0.208 , (Not available) 0.191 , (Not available)	Depositor DCC
R_{free} test set	No test flags present.	wwPDB-VP
Wilson B-factor (Å ²)	21.5	Xtriage
Anisotropy	0.483	Xtriage
Bulk solvent k_{sol} (e/Å ³), B_{sol} (Å ²)	0.44 , 92.1	EDS
L-test for twinning ²	$\langle L \rangle = 0.47$, $\langle L^2 \rangle = 0.30$	Xtriage
Estimated twinning fraction	0.028 for k,h,-l	Xtriage
F_o, F_c correlation	0.95	EDS
Total number of atoms	1131	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 12.06% 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

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

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	1.52	5/990 (0.5%)	2.43	61/1329 (4.6%)

All (5) bond length outliers are listed below:

Mol	Chain	Res	Type	Atoms	Z	Observed(Å)	Ideal(Å)
1	A	70	LYS	N-CA	6.41	1.54	1.46
1	A	20	ILE	CA-CB	6.08	1.61	1.54
1	A	53	PHE	N-CA	5.63	1.52	1.46
1	A	11	VAL	CA-CB	5.59	1.60	1.54
1	A	72	ILE	CA-CB	5.42	1.60	1.54

All (61) bond angle outliers are listed below:

Mol	Chain	Res	Type	Atoms	Z	Observed(°)	Ideal(°)
1	A	31	ASN	OD1-CG-ND2	12.14	134.74	122.60
1	A	20	ILE	CA-C-O	11.63	133.36	121.27
1	A	18	ARG	NE-CZ-NH1	10.42	131.92	121.50
1	A	66	LEU	O-C-N	8.94	132.34	122.15
1	A	55	ILE	CA-C-O	8.86	128.99	120.31
1	A	39	GLY	O-C-N	8.84	130.68	122.19
1	A	125	GLU	CA-CB-CG	8.57	131.24	114.10
1	A	89	GLU	CA-C-O	-8.56	111.17	120.24
1	A	44	ASN	CA-C-O	7.99	129.45	120.90
1	A	39	GLY	CA-C-O	-7.84	112.68	120.75
1	A	78	MET	CB-CA-C	-7.71	97.37	110.64
1	A	18	ARG	CD-NE-CZ	7.68	135.15	124.40
1	A	45	LYS	CA-C-O	-7.61	112.86	120.70
1	A	31	ASN	CA-CB-CG	-7.55	105.05	112.60
1	A	11	VAL	O-C-N	7.53	131.91	123.10
1	A	20	ILE	O-C-N	-7.46	114.48	121.94

Continued on next page...

Continued from previous page...

Mol	Chain	Res	Type	Atoms	Z	Observed(°)	Ideal(°)
1	A	44	ASN	CA-CB-CG	7.43	120.03	112.60
1	A	46	LEU	O-C-N	7.42	130.90	122.22
1	A	22	ARG	CD-NE-CZ	7.26	134.57	124.40
1	A	121	ASN	OD1-CG-ND2	7.23	129.83	122.60
1	A	27	GLU	O-C-N	-7.23	114.46	122.12
1	A	18	ARG	NH1-CZ-NH2	-7.06	110.13	119.30
1	A	11	VAL	CA-C-O	-6.98	113.06	120.53
1	A	69	LEU	O-C-N	6.81	129.08	122.07
1	A	72	ILE	O-C-N	6.70	128.48	121.91
1	A	59	ASN	OD1-CG-ND2	-6.53	116.07	122.60
1	A	32	ASN	CA-C-O	-6.42	114.39	121.58
1	A	43	LEU	CA-C-O	-6.25	113.80	120.42
1	A	77	ALA	N-CA-C	6.04	118.83	111.82
1	A	6	LEU	CB-CA-C	5.96	118.78	109.84
1	A	25	LEU	O-C-N	5.90	128.15	122.07
1	A	63	MET	O-C-N	5.90	131.03	123.24
1	A	11	VAL	N-CA-C	5.88	116.32	107.80
1	A	66	LEU	CA-C-O	-5.88	114.19	120.42
1	A	126	LYS	CA-CB-CG	5.87	125.84	114.10
1	A	59	ASN	CA-C-O	5.84	126.62	120.54
1	A	21	VAL	O-C-N	5.80	127.49	121.87
1	A	122	LYS	CA-C-N	5.71	128.52	120.42
1	A	122	LYS	C-N-CA	5.71	128.52	120.42
1	A	78	MET	CA-C-O	-5.58	112.89	119.48
1	A	78	MET	O-C-N	5.54	128.90	122.19
1	A	107	VAL	CA-C-O	5.51	126.82	120.76
1	A	72	ILE	CA-C-O	-5.46	115.38	121.17
1	A	52	GLY	O-C-N	5.44	129.77	122.70
1	A	60	MET	O-C-N	5.43	125.65	121.85
1	A	43	LEU	O-C-N	5.43	128.34	122.15
1	A	75	ASP	CA-CB-CG	5.43	118.03	112.60
1	A	16	THR	CA-CB-OG1	-5.40	101.51	109.60
1	A	73	ARG	NE-CZ-NH1	5.34	126.84	121.50
1	A	106	TYR	N-CA-CB	-5.31	101.62	111.13
1	A	85	MET	CA-C-O	-5.27	114.86	120.92
1	A	106	TYR	CA-C-O	-5.24	114.32	120.60
1	A	79	SER	CA-C-N	-5.19	114.41	122.67
1	A	79	SER	C-N-CA	-5.19	114.41	122.67
1	A	92	LYS	N-CA-CB	-5.14	102.28	109.94
1	A	79	SER	CA-C-O	-5.12	114.47	120.20
1	A	55	ILE	CA-CB-CG2	-5.11	101.81	110.50
1	A	59	ASN	N-CA-C	5.09	116.90	108.20

Continued on next page...

Continued from previous page...

Mol	Chain	Res	Type	Atoms	Z	Observed(°)	Ideal(°)
1	A	46	LEU	CA-C-O	-5.07	114.37	120.10
1	A	22	ARG	NE-CZ-NH1	5.04	126.54	121.50
1	A	19	ARG	CD-NE-CZ	-5.04	117.35	124.40

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	991	0	1005	29	0
2	A	140	0	0	6	0
All	All	1131	0	1005	29	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 14.

All (29) 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:12:ASP:OD2	1:A:57[B]:CYQ:SG	2.18	1.01
1:A:87:THR:HG21	1:A:106:TYR:CZ	2.27	0.70
1:A:127:LEU:HB3	1:A:129:MET:HG3	1.79	0.65
1:A:46:LEU:HB3	1:A:78:MET:CE	2.33	0.58
1:A:87:THR:HG21	1:A:106:TYR:OH	2.04	0.58
1:A:87:THR:HG21	1:A:106:TYR:CE2	2.39	0.57
1:A:47:GLN:NE2	2:A:304:HOH:O	2.31	0.57
1:A:82:PRO:HG3	1:A:127:LEU:CD2	2.34	0.56
1:A:19:ARG:HD2	2:A:333:HOH:O	2.05	0.55
1:A:7:LYS:HE3	1:A:51:TYR:CZ	2.42	0.55
1:A:4:LYS:NZ	1:A:28:LEU:O	2.39	0.54
1:A:7:LYS:HE3	1:A:51:TYR:CE1	2.42	0.54
1:A:104:SER:O	1:A:126:LYS:NZ	2.40	0.52
1:A:122:LYS:O	1:A:126:LYS:HB2	2.10	0.51
1:A:2:ALA:HB2	1:A:124:PHE:CD2	2.48	0.49

Continued on next page...

Continued from previous page...

Atom-1	Atom-2	Interatomic distance (Å)	Clash overlap (Å)
1:A:58:TRP:HE3	1:A:85:MET:HG2	1.77	0.49
1:A:75:ASP:O	1:A:79:SER:HB3	2.13	0.49
1:A:46:LEU:HB3	1:A:78:MET:HE1	1.94	0.48
1:A:44:ASN:ND2	2:A:250:HOH:O	2.47	0.48
1:A:127:LEU:O	1:A:128:GLY:C	2.57	0.47
1:A:90:ALA:HB2	1:A:108:VAL:CG2	2.45	0.46
1:A:19:ARG:CD	2:A:333:HOH:O	2.64	0.46
1:A:45:LYS:NZ	2:A:269:HOH:O	2.51	0.44
1:A:53:PHE:CD2	1:A:82:PRO:HB2	2.53	0.43
1:A:19:ARG:HB2	2:A:315:HOH:O	2.18	0.43
1:A:46:LEU:CB	1:A:78:MET:HE1	2.49	0.43
1:A:58:TRP:CE3	1:A:85:MET:HG2	2.54	0.43
1:A:90:ALA:HB2	1:A:108:VAL:HG21	2.01	0.42
1:A:43:LEU:O	1:A:47:GLN:HG3	2.20	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	126/128 (98%)	125 (99%)	1 (1%)	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	102/101 (101%)	101 (99%)	1 (1%)	68 58

All (1) residues with a non-rotameric sidechain are listed below:

Mol	Chain	Res	Type
1	A	109	LYS

Sometimes sidechains can be flipped to improve hydrogen bonding and reduce clashes. There are no such sidechains identified.

5.3.3 RNA ⓘ

There are no RNA molecules in this entry.

5.4 Non-standard residues in protein, DNA, RNA chains ⓘ

2 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	CYQ	A	57[A]	-	8,10,11	2.51	4 (50%)	9,13,15	1.70	1 (11%)
1	CYQ	A	57[B]	-	8,10,11	2.47	4 (50%)	9,13,15	1.70	2 (22%)

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	CYQ	A	57[A]	-	-	0/3/9/11	-
1	CYQ	A	57[B]	-	-	2/3/9/11	-

All (8) bond length outliers are listed below:

Mol	Chain	Res	Type	Atoms	Z	Observed(Å)	Ideal(Å)
1	A	57[A]	CYQ	P-O2P	-4.24	1.45	1.55
1	A	57[A]	CYQ	P-O3P	-4.24	1.45	1.55
1	A	57[B]	CYQ	P-O2P	-4.22	1.45	1.55
1	A	57[B]	CYQ	P-O3P	-4.11	1.45	1.55
1	A	57[B]	CYQ	P-O1P	-2.36	1.45	1.50
1	A	57[A]	CYQ	P-O1P	-2.36	1.45	1.50
1	A	57[A]	CYQ	CB-CA	-2.24	1.47	1.53
1	A	57[B]	CYQ	CB-CA	-2.24	1.47	1.53

All (3) bond angle outliers are listed below:

Mol	Chain	Res	Type	Atoms	Z	Observed(°)	Ideal(°)
1	A	57[B]	CYQ	O3P-P-O2P	-3.62	97.65	107.96
1	A	57[A]	CYQ	O3P-P-O2P	-3.54	97.86	107.96
1	A	57[B]	CYQ	O2P-P-CD	2.04	113.17	107.06

There are no chirality outliers.

All (2) torsion outliers are listed below:

Mol	Chain	Res	Type	Atoms
1	A	57[B]	CYQ	N-CA-CB-SG
1	A	57[B]	CYQ	C-CA-CB-SG

There are no ring outliers.

1 monomer is involved in 1 short contact:

Mol	Chain	Res	Type	Clashes	Symm-Clashes
1	A	57[B]	CYQ	1	0

5.5 Carbohydrates [i](#)

There are no oligosaccharides in this entry.

5.6 Ligand geometry [i](#)

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 ⓘ

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	127/128 (99%)	-0.10	0 100 100	10, 20, 35, 46	1 (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, 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(Å ²)	Q<0.9
1	CYQ	A	57[A]	11/12	0.79	0.12	12,15,20,20	6
1	CYQ	A	57[B]	11/12	0.79	0.12	12,15,20,20	6

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.