



Full wwPDB X-ray Structure Validation Report ⓘ

Mar 12, 2026 – 02:33 PM UTC

PDB ID : 2A10 / pdb_00002a10
Title : carboxysome shell protein ccmK4
Authors : Kerfeld, C.A.; Sawaya, M.R.; Tanaka, S.; Nguyen, C.V.; Phillips, M.; Beeby, M.; Yeates, T.O.
Deposited on : 2005-06-17
Resolution : 1.80 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

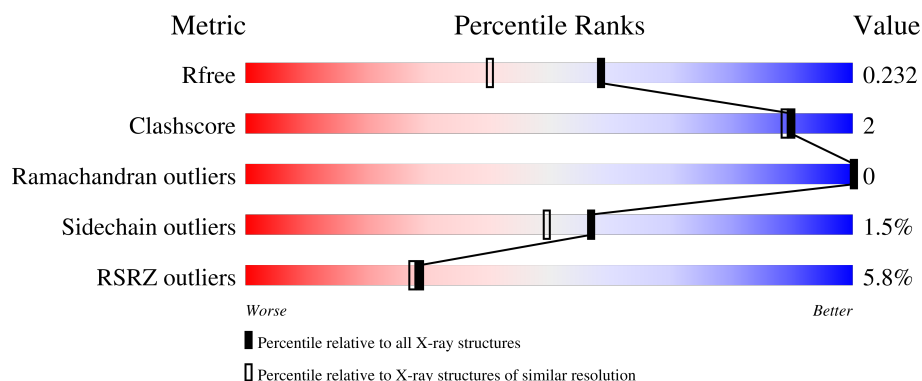
1 Overall quality at a glance

The following experimental techniques were used to determine the structure:

X-RAY DIFFRACTION

The reported resolution of this entry is 1.80 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	7662 (1.80-1.80)
Clashscore	190562	8479 (1.80-1.80)
Ramachandran outliers	187476	8391 (1.80-1.80)
Sidechain outliers	187428	8390 (1.80-1.80)
RSRZ outliers	180081	7663 (1.80-1.80)

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	125	6% 81% •• 17%
1	B	125	8% 80% 5% 15%
1	C	125	7% 84% • 14%
1	D	125	2% 74% 7% 18%
1	E	125	2% 77% 5% 18%

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Mol	Chain	Length	Quality of chain
1	F	125	 A horizontal bar chart showing the quality of chain F. The bar is divided into four segments: a small red segment at the beginning labeled '5%', a large green segment labeled '79%', a small yellow segment labeled '5%', and a grey segment at the end labeled '16%'.

2 Entry composition

There are 2 unique types of molecules in this entry. The entry contains 4962 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 Carbon dioxide concentrating mechanism protein ccmK homolog 4.

Mol	Chain	Residues	Atoms					ZeroOcc	AltConf	Trace
1	A	104	Total	C	N	O	S	0	1	0
			771	490	136	143	2			
1	B	106	Total	C	N	O	S	0	1	0
			782	496	139	145	2			
1	C	107	Total	C	N	O	S	0	1	0
			792	503	140	147	2			
1	D	102	Total	C	N	O	S	0	2	0
			767	486	135	144	2			
1	E	102	Total	C	N	O	S	0	1	0
			764	485	135	142	2			
1	F	105	Total	C	N	O	S	0	2	0
			780	494	138	146	2			

There are 84 discrepancies between the modelled and reference sequences:

Chain	Residue	Modelled	Actual	Comment	Reference
A	1	MET	-	initiating methionine	UNP P73407
A	113	GLY	-	expression tag	UNP P73407
A	114	VAL	-	expression tag	UNP P73407
A	115	PRO	-	expression tag	UNP P73407
A	116	ARG	-	expression tag	UNP P73407
A	117	GLY	-	expression tag	UNP P73407
A	118	LEU	-	expression tag	UNP P73407
A	119	GLU	-	expression tag	UNP P73407
A	120	HIS	-	expression tag	UNP P73407
A	121	HIS	-	expression tag	UNP P73407
A	122	HIS	-	expression tag	UNP P73407
A	123	HIS	-	expression tag	UNP P73407
A	124	HIS	-	expression tag	UNP P73407
A	125	HIS	-	expression tag	UNP P73407
B	1	MET	-	initiating methionine	UNP P73407
B	113	GLY	-	expression tag	UNP P73407

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Chain	Residue	Modelled	Actual	Comment	Reference
B	114	VAL	-	expression tag	UNP P73407
B	115	PRO	-	expression tag	UNP P73407
B	116	ARG	-	expression tag	UNP P73407
B	117	GLY	-	expression tag	UNP P73407
B	118	LEU	-	expression tag	UNP P73407
B	119	GLU	-	expression tag	UNP P73407
B	120	HIS	-	expression tag	UNP P73407
B	121	HIS	-	expression tag	UNP P73407
B	122	HIS	-	expression tag	UNP P73407
B	123	HIS	-	expression tag	UNP P73407
B	124	HIS	-	expression tag	UNP P73407
B	125	HIS	-	expression tag	UNP P73407
C	1	MET	-	initiating methionine	UNP P73407
C	113	GLY	-	expression tag	UNP P73407
C	114	VAL	-	expression tag	UNP P73407
C	115	PRO	-	expression tag	UNP P73407
C	116	ARG	-	expression tag	UNP P73407
C	117	GLY	-	expression tag	UNP P73407
C	118	LEU	-	expression tag	UNP P73407
C	119	GLU	-	expression tag	UNP P73407
C	120	HIS	-	expression tag	UNP P73407
C	121	HIS	-	expression tag	UNP P73407
C	122	HIS	-	expression tag	UNP P73407
C	123	HIS	-	expression tag	UNP P73407
C	124	HIS	-	expression tag	UNP P73407
C	125	HIS	-	expression tag	UNP P73407
D	1	MET	-	initiating methionine	UNP P73407
D	113	GLY	-	expression tag	UNP P73407
D	114	VAL	-	expression tag	UNP P73407
D	115	PRO	-	expression tag	UNP P73407
D	116	ARG	-	expression tag	UNP P73407
D	117	GLY	-	expression tag	UNP P73407
D	118	LEU	-	expression tag	UNP P73407
D	119	GLU	-	expression tag	UNP P73407
D	120	HIS	-	expression tag	UNP P73407
D	121	HIS	-	expression tag	UNP P73407
D	122	HIS	-	expression tag	UNP P73407
D	123	HIS	-	expression tag	UNP P73407
D	124	HIS	-	expression tag	UNP P73407
D	125	HIS	-	expression tag	UNP P73407
E	1	MET	-	initiating methionine	UNP P73407
E	113	GLY	-	expression tag	UNP P73407

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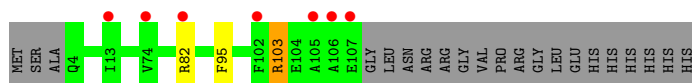
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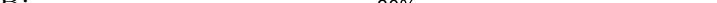
Chain	Residue	Modelled	Actual	Comment	Reference
E	114	VAL	-	expression tag	UNP P73407
E	115	PRO	-	expression tag	UNP P73407
E	116	ARG	-	expression tag	UNP P73407
E	117	GLY	-	expression tag	UNP P73407
E	118	LEU	-	expression tag	UNP P73407
E	119	GLU	-	expression tag	UNP P73407
E	120	HIS	-	expression tag	UNP P73407
E	121	HIS	-	expression tag	UNP P73407
E	122	HIS	-	expression tag	UNP P73407
E	123	HIS	-	expression tag	UNP P73407
E	124	HIS	-	expression tag	UNP P73407
E	125	HIS	-	expression tag	UNP P73407
F	1	MET	-	initiating methionine	UNP P73407
F	113	GLY	-	expression tag	UNP P73407
F	114	VAL	-	expression tag	UNP P73407
F	115	PRO	-	expression tag	UNP P73407
F	116	ARG	-	expression tag	UNP P73407
F	117	GLY	-	expression tag	UNP P73407
F	118	LEU	-	expression tag	UNP P73407
F	119	GLU	-	expression tag	UNP P73407
F	120	HIS	-	expression tag	UNP P73407
F	121	HIS	-	expression tag	UNP P73407
F	122	HIS	-	expression tag	UNP P73407
F	123	HIS	-	expression tag	UNP P73407
F	124	HIS	-	expression tag	UNP P73407
F	125	HIS	-	expression tag	UNP P73407

- Molecule 2 is water.

Mol	Chain	Residues	Atoms	ZeroOcc	AltConf
2	A	46	Total O 46 46	0	0
2	B	57	Total O 57 57	0	0
2	C	53	Total O 53 53	0	0
2	D	45	Total O 45 45	0	0
2	E	58	Total O 58 58	0	0
2	F	47	Total O 47 47	0	0

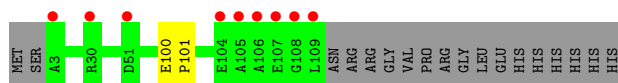
- Molecule 1: Carbon dioxide concentrating mechanism protein ccmK homolog 4



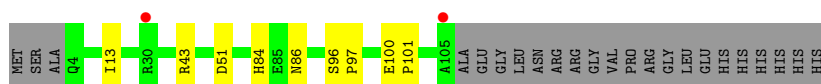
- Chain B:  8% 80% 5% 15%

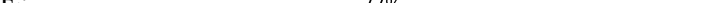


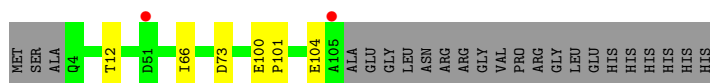
- Chain C:  7% 84% 14%



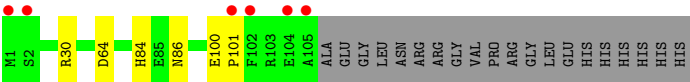
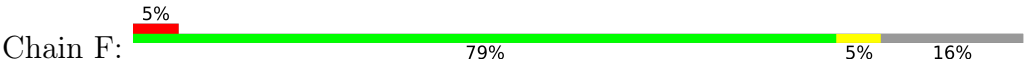
- Chain D:



- Chain E:  2% 77% 5% 18%



- 
- WORLD WIDE
PDB
PROTEIN DATA BANK



4 Data and refinement statistics

Property	Value	Source
Space group	P 21 21 21	Depositor
Cell constants a, b, c, α , β , γ	84.76Å 87.00Å 96.51Å 90.00° 90.00° 90.00°	Depositor
Resolution (Å)	64.55 – 1.80 64.55 – 1.80	Depositor EDS
% Data completeness (in resolution range)	98.2 (64.55-1.80) 98.3 (64.55-1.80)	Depositor EDS
R_{merge}	(Not available)	Depositor
R_{sym}	0.08	Depositor
$\langle I/\sigma(I) \rangle$ ¹	4.41 (at 1.81Å)	Xtriage
Refinement program	REFMAC 5.2	Depositor
R, R_{free}	0.193 , 0.227 0.203 , 0.232	Depositor DCC
R_{free} test set	3340 reflections (0.87%)	wwPDB-VP
Wilson B-factor (Å ²)	22.1	Xtriage
Anisotropy	0.219	Xtriage
Bulk solvent k_{sol} (e/Å ³), B_{sol} (Å ²)	0.34 , 38.0	EDS
L-test for twinning ²	$\langle L \rangle = 0.51$, $\langle L^2 \rangle = 0.35$	Xtriage
Estimated twinning fraction	0.007 for k,h,-l	Xtriage
F_o, F_c correlation	0.94	EDS
Total number of atoms	4962	wwPDB-VP
Average B, all atoms (Å ²)	25.0	wwPDB-VP

Xtriage's analysis on translational NCS is as follows: *The largest off-origin peak in the Patterson function is 3.70% 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	0.70	0/792	0.82	0/1077
1	B	0.74	0/803	0.84	0/1092
1	C	0.78	0/813	0.86	0/1105
1	D	0.76	0/793	0.85	0/1078
1	E	0.70	0/785	0.84	0/1067
1	F	0.74	0/806	0.85	0/1096
All	All	0.74	0/4792	0.84	0/6515

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	771	0	783	1	0
1	B	782	0	798	3	0
1	C	792	0	808	1	0
1	D	767	0	780	7	0
1	E	764	0	780	3	0
1	F	780	0	793	2	0
2	A	46	0	0	0	0
2	B	57	0	0	1	0
2	C	53	0	0	0	0
2	D	45	0	0	1	0

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Mol	Chain	Non-H	H(model)	H(added)	Clashes	Symm-Clashes
2	E	58	0	0	0	0
2	F	47	0	0	0	0
All	All	4962	0	4742	17	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 (17) 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:D:84:HIS:HD2	1:D:86:ASN:H	1.49	0.60
1:F:84:HIS:HD2	1:F:86:ASN:H	1.52	0.55
1:E:12:THR:HG22	1:E:66:ILE:HD13	1.89	0.53
1:D:13:ILE:HD13	1:D:43:ARG:CG	2.41	0.51
1:D:13:ILE:HB	2:D:165:HOH:O	2.13	0.48
1:D:13:ILE:HD13	1:D:43:ARG:HG3	1.97	0.47
1:D:100:GLU:N	1:D:101:PRO:CD	2.78	0.46
1:F:100:GLU:N	1:F:101:PRO:CD	2.79	0.46
1:D:96:SER:HB2	1:D:97:PRO:HD2	1.99	0.45
1:E:100:GLU:N	1:E:101:PRO:CD	2.82	0.43
1:B:13:ILE:HB	2:B:167:HOH:O	2.19	0.42
1:E:100:GLU:O	1:E:104:GLU:HG3	2.20	0.42
1:B:53:GLN:NE2	1:B:56:LYS:HE3	2.34	0.42
1:A:95:PHE:CE1	1:A:103:ARG:HG3	2.55	0.41
1:C:100:GLU:N	1:C:101:PRO:CD	2.83	0.41
1:B:100:GLU:N	1:B:101:PRO:CD	2.83	0.41
1:D:84:HIS:CD2	1:D:86:ASN:H	2.34	0.41

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	103/125 (82%)	103 (100%)	0	0	100	100
1	B	105/125 (84%)	105 (100%)	0	0	100	100
1	C	106/125 (85%)	106 (100%)	0	0	100	100
1	D	102/125 (82%)	102 (100%)	0	0	100	100
1	E	101/125 (81%)	101 (100%)	0	0	100	100
1	F	105/125 (84%)	105 (100%)	0	0	100	100
All	All	622/750 (83%)	622 (100%)	0	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	78/96 (81%)	76 (97%)	2 (3%)	40	28
1	B	79/96 (82%)	78 (99%)	1 (1%)	61	54
1	C	80/96 (83%)	80 (100%)	0	100	100
1	D	80/96 (83%)	78 (98%)	2 (2%)	42	30
1	E	79/96 (82%)	78 (99%)	1 (1%)	61	54
1	F	80/96 (83%)	77 (96%)	3 (4%)	29	17
All	All	476/576 (83%)	467 (98%)	9 (2%)	57	41

All (9) residues with a non-rotameric sidechain are listed below:

Mol	Chain	Res	Type
1	A	82	ARG
1	A	103	ARG
1	B	2	SER
1	D	51[A]	ASP
1	D	51[B]	ASP
1	E	73	ASP
1	F	30	ARG

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Mol	Chain	Res	Type
1	F	64[A]	ASP
1	F	64[B]	ASP

Sometimes sidechains can be flipped to improve hydrogen bonding and reduce clashes. All (7) such sidechains are listed below:

Mol	Chain	Res	Type
1	B	53	GLN
1	D	47	ASN
1	D	67	ASN
1	D	84	HIS
1	E	53	GLN
1	E	67	ASN
1	F	84	HIS

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](#)

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	104/125 (83%)	0.75	7 (6%) 24 22	20, 24, 35, 43	1 (0%)
1	B	106/125 (84%)	0.68	10 (9%) 14 12	17, 22, 34, 44	1 (0%)
1	C	107/125 (85%)	0.58	9 (8%) 17 15	18, 22, 37, 49	1 (0%)
1	D	102/125 (81%)	0.36	2 (1%) 65 65	17, 23, 34, 40	2 (1%)
1	E	102/125 (81%)	0.30	2 (1%) 65 65	20, 23, 35, 44	1 (0%)
1	F	105/125 (84%)	0.59	6 (5%) 29 28	17, 24, 37, 45	2 (1%)
All	All	626/750 (83%)	0.55	36 (5%) 29 27	17, 23, 37, 49	8 (1%)

All (36) RSRZ outliers are listed below:

Mol	Chain	Res	Type	RSRZ
1	C	109	LEU	5.2
1	F	105	ALA	5.0
1	B	106	ALA	4.9
1	E	105	ALA	3.9
1	C	107	GLU	3.8
1	B	3	ALA	3.8
1	B	97	PRO	3.5
1	C	105	ALA	3.4
1	C	3	ALA	3.4
1	A	105	ALA	3.2
1	A	107	GLU	3.1
1	B	1	MET	3.0
1	D	105	ALA	3.0
1	C	104	GLU	2.9
1	F	104	GLU	2.9
1	A	82	ARG	2.9
1	B	105	ALA	2.8
1	C	51	ASP	2.8
1	F	1	MET	2.7

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Mol	Chain	Res	Type	RSRZ
1	B	2	SER	2.7
1	C	108	GLY	2.6
1	A	106	ALA	2.6
1	F	101	PRO	2.5
1	A	13	ILE	2.5
1	B	104	GLU	2.5
1	C	106	ALA	2.4
1	F	2	SER	2.4
1	E	51	ASP	2.3
1	A	102	PHE	2.3
1	A	74	VAL	2.2
1	C	30	ARG	2.2
1	B	4	GLN	2.1
1	D	30	ARG	2.1
1	F	102	PHE	2.0
1	B	30	ARG	2.0
1	B	73	ASP	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.