



Full wwPDB X-ray Structure Validation Report ⓘ

Mar 14, 2026 – 01:30 AM UTC

PDB ID : 2ZD9 / pdb_00002zd9
Title : Structure of a Bacterial Cyclic-Nucleotide Regulated Ion Channel
Authors : Clayton, G.M.; Cabral-Morais, J.M.
Deposited on : 2007-11-21
Resolution : 4.00 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

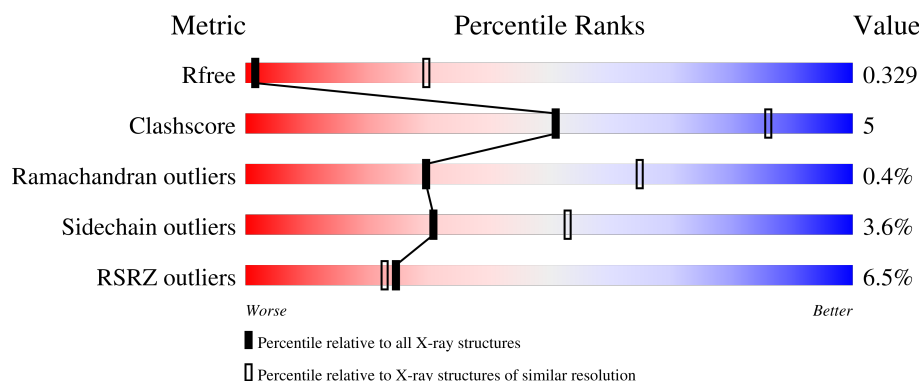
1 Overall quality at a glance

The following experimental techniques were used to determine the structure:

X-RAY DIFFRACTION

The reported resolution of this entry is 4.00 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))
R_{free}	180053	1082 (4.20-3.80)
Clashscore	190562	1129 (4.20-3.80)
Ramachandran outliers	187476	1064 (4.20-3.80)
Sidechain outliers	187428	1055 (4.20-3.80)
RSRZ outliers	180081	1082 (4.20-3.80)

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	355	5% 52% 10% 37%
1	B	355	3% 56% 9% 35%
1	C	355	5% 56% 9% 34%
1	D	355	5% 52% 12% 37%

The following table lists non-polymeric compounds, carbohydrate monomers and non-standard

residues in protein, DNA, RNA chains that are outliers for geometric or electron-density-fit criteria:

Mol	Type	Chain	Res	Chirality	Geometry	Clashes	Electron density
2	K	B	356	-	-	-	X

2 Entry composition

There are 2 unique types of molecules in this entry. The entry contains 6701 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 Mll3241 protein.

Mol	Chain	Residues	Atoms					ZeroOcc	AltConf	Trace
1	A	223	Total	C	N	O	S	0	0	0
			1646	1079	280	282	5			
1	B	231	Total	C	N	O	S	0	0	0
			1688	1105	288	290	5			
1	C	234	Total	C	N	O	S	0	0	0
			1703	1114	291	293	5			
1	D	225	Total	C	N	O	S	0	0	0
			1659	1088	282	284	5			

- Molecule 2 is POTASSIUM ION (CCD ID: K) (formula: K).

Mol	Chain	Residues	Atoms		ZeroOcc	AltConf
2	A	2	Total	K	0	0
			2	2		
2	B	1	Total	K	0	0
			1	1		
2	C	2	Total	K	0	0
			2	2		

4 Data and refinement statistics

Property	Value	Source
Space group	H 3	Depositor
Cell constants a, b, c, α , β , γ	283.29Å 283.29Å 103.51Å 90.00° 90.00° 120.00°	Depositor
Resolution (Å)	141.42 – 4.00 141.42 – 4.00	Depositor EDS
% Data completeness (in resolution range)	99.6 (141.42-4.00) 99.6 (141.42-4.00)	Depositor EDS
R_{merge}	(Not available)	Depositor
R_{sym}	(Not available)	Depositor
$\langle I/\sigma(I) \rangle$ ¹	2.22 (at 4.00Å)	Xtriage
Refinement program	REFMAC 5.2.0019	Depositor
R, R_{free}	0.307 , 0.333 0.296 , 0.329	Depositor DCC
R_{free} test set	1324 reflections (5.06%)	wwPDB-VP
Wilson B-factor (Å ²)	117.5	Xtriage
Anisotropy	0.382	Xtriage
Bulk solvent k_{sol} (e/Å ³), B_{sol} (Å ²)	0.24 , 73.0	EDS
L-test for twinning ²	$\langle L \rangle = 0.39$, $\langle L^2 \rangle = 0.22$	Xtriage
Estimated twinning fraction	0.105 for h,-h-k,-l	Xtriage
F_o, F_c correlation	0.90	EDS
Total number of atoms	6701	wwPDB-VP
Average B, all atoms (Å ²)	142.0	wwPDB-VP

Xtriage's analysis on translational NCS is as follows: *The largest off-origin peak in the Patterson function is 3.71% 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:
K

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	0.47	0/1682	0.83	0/2302
1	B	0.49	0/1724	0.86	1/2361 (0.0%)
1	C	0.48	1/1739 (0.1%)	0.85	1/2382 (0.0%)
1	D	0.48	0/1695	0.83	0/2320
All	All	0.48	1/6840 (0.0%)	0.84	2/9365 (0.0%)

All (1) bond length outliers are listed below:

Mol	Chain	Res	Type	Atoms	Z	Observed(Å)	Ideal(Å)
1	C	162	ILE	CA-CB	5.54	1.56	1.54

All (2) bond angle outliers are listed below:

Mol	Chain	Res	Type	Atoms	Z	Observed(°)	Ideal(°)
1	B	234	PRO	N-CA-CB	8.63	110.52	103.36
1	C	234	PRO	N-CA-CB	7.54	110.34	103.33

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	1646	0	1690	22	0

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Mol	Chain	Non-H	H(model)	H(added)	Clashes	Symm-Clashes
1	B	1688	0	1712	17	0
1	C	1703	0	1719	19	0
1	D	1659	0	1700	24	0
2	A	2	0	0	0	0
2	B	1	0	0	0	0
2	C	2	0	0	0	0
All	All	6701	0	6821	70	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 5.

All (70) 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:193:GLY:HA2	1:D:170:VAL:HG11	1.72	0.70
1:B:19:ALA:HB3	1:B:20:PRO:HD3	1.76	0.67
1:A:170:VAL:HG11	1:B:193:GLY:HA2	1.79	0.64
1:A:56:LEU:HD22	1:A:82:VAL:HG21	1.81	0.62
1:C:140:LEU:HD11	1:C:170:VAL:HG22	1.80	0.62
1:D:19:ALA:HB3	1:D:20:PRO:HD3	1.84	0.60
1:D:56:LEU:HD22	1:D:82:VAL:HG21	1.85	0.57
1:A:133:THR:HG23	1:B:197:MET:HE1	1.89	0.55
1:D:171:VAL:HG22	1:D:178:TYR:HD2	1.71	0.55
1:A:19:ALA:HB3	1:A:20:PRO:HD3	1.89	0.55
1:C:19:ALA:HB3	1:C:20:PRO:HD3	1.88	0.54
1:A:140:LEU:HD11	1:A:170:VAL:HG22	1.90	0.54
1:A:203:PHE:HZ	1:B:175:THR:HG21	1.73	0.53
1:D:150:ILE:HG22	1:D:151:GLU:HG3	1.91	0.53
1:B:161:SER:HB2	1:B:163:PRO:HD2	1.92	0.52
1:A:171:VAL:HG12	1:A:171:VAL:O	2.09	0.52
1:A:171:VAL:CG1	1:A:178:TYR:H	2.24	0.51
1:C:115:PHE:N	1:C:116:PRO:HD2	2.26	0.51
1:C:150:ILE:HG22	1:C:151:GLU:HG3	1.93	0.51
1:D:72:THR:N	1:D:73:PRO:HD2	2.26	0.51
1:C:152:ARG:HA	1:C:159:PHE:O	2.11	0.51
1:C:199:GLY:O	1:C:203:PHE:HB2	2.11	0.51
1:D:162:ILE:HB	1:D:163:PRO:HD3	1.92	0.50
1:A:106:LEU:HD23	1:A:109:LEU:HD12	1.95	0.49
1:B:191:LEU:O	1:B:195:VAL:HG23	2.13	0.49
1:D:191:LEU:O	1:D:195:VAL:HG23	2.13	0.48
1:D:140:LEU:HD11	1:D:170:VAL:CG2	2.43	0.48

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Atom-1	Atom-2	Interatomic distance (Å)	Clash overlap (Å)
1:D:140:LEU:HD11	1:D:170:VAL:HG22	1.96	0.48
1:B:118:LEU:HG	1:B:122:LEU:HD13	1.95	0.48
1:C:103:VAL:HG12	1:C:103:VAL:O	2.14	0.48
1:C:56:LEU:HD22	1:C:82:VAL:HG21	1.95	0.47
1:B:150:ILE:HG22	1:B:151:GLU:HG3	1.97	0.47
1:D:94:SER:C	1:D:96:ASP:H	2.23	0.47
1:A:162:ILE:HB	1:A:163:PRO:HD3	1.97	0.47
1:B:140:LEU:HD11	1:B:170:VAL:HG22	1.97	0.47
1:A:163:PRO:HA	1:A:166:MET:HB2	1.97	0.46
1:A:197:MET:HE1	1:D:133:THR:HG23	1.96	0.46
1:C:72:THR:N	1:C:73:PRO:HD2	2.30	0.46
1:D:115:PHE:N	1:D:116:PRO:CD	2.78	0.46
1:B:84:VAL:HB	1:B:85:PRO:HD3	1.97	0.46
1:D:101:CYS:C	1:D:103:VAL:H	2.24	0.46
1:A:113:THR:HB	1:B:127:ARG:HD3	1.99	0.45
1:A:167:TRP:O	1:A:171:VAL:HG23	2.17	0.45
1:B:115:PHE:N	1:B:116:PRO:CD	2.80	0.45
1:C:96:ASP:CG	1:D:152:ARG:HH12	2.25	0.44
1:A:115:PHE:N	1:A:116:PRO:HD2	2.32	0.44
1:C:113:THR:HB	1:D:127:ARG:HD3	1.99	0.44
1:A:203:PHE:CE2	1:B:200:ILE:HG12	2.52	0.44
1:B:204:GLY:O	1:B:208:GLY:N	2.48	0.43
1:C:191:LEU:O	1:C:195:VAL:HG23	2.17	0.43
1:D:163:PRO:HA	1:D:166:MET:HB2	1.99	0.43
1:D:65:ALA:HB1	1:D:69:ARG:HB3	2.01	0.43
1:C:105:LEU:HD22	1:D:138:VAL:HA	2.00	0.43
1:D:12:PRO:O	1:D:16:VAL:HG23	2.18	0.43
1:C:170:VAL:HG11	1:D:193:GLY:HA2	2.01	0.42
1:B:94:SER:C	1:B:96:ASP:H	2.26	0.42
1:A:150:ILE:HG22	1:A:151:GLU:HG3	2.00	0.42
1:C:193:GLY:HA2	1:C:196:MET:HE3	2.01	0.42
1:D:11:ALA:HB3	1:D:12:PRO:HD3	2.01	0.41
1:C:12:PRO:O	1:C:16:VAL:HG23	2.20	0.41
1:A:94:SER:C	1:A:96:ASP:H	2.28	0.41
1:A:191:LEU:O	1:A:195:VAL:HG23	2.21	0.41
1:C:56:LEU:O	1:C:60:LEU:HB2	2.21	0.41
1:C:102:ALA:C	1:C:104:TRP:H	2.28	0.41
1:C:72:THR:N	1:C:73:PRO:CD	2.84	0.41
1:D:14:ASN:HD22	1:D:14:ASN:HA	1.70	0.41
1:B:72:THR:N	1:B:73:PRO:HD2	2.36	0.41
1:A:53:LEU:HA	1:A:82:VAL:HG11	2.04	0.40

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Atom-1	Atom-2	Interatomic distance (Å)	Clash overlap (Å)
1:A:175:THR:HA	1:D:176:THR:HG23	2.04	0.40
1:B:186:PHE:O	1:B:190:VAL:HG23	2.21	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	221/355 (62%)	200 (90%)	20 (9%)	1 (0%)	24	60
1	B	229/355 (64%)	202 (88%)	27 (12%)	0	100	100
1	C	232/355 (65%)	201 (87%)	30 (13%)	1 (0%)	30	65
1	D	223/355 (63%)	204 (92%)	17 (8%)	2 (1%)	14	48
All	All	905/1420 (64%)	807 (89%)	94 (10%)	4 (0%)	30	65

All (4) Ramachandran outliers are listed below:

Mol	Chain	Res	Type
1	C	11	ALA
1	D	177	GLY
1	A	230	VAL
1	D	230	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.

Mol	Chain	Analysed	Rotameric	Outliers	Percentiles	
1	A	159/273 (58%)	150 (94%)	9 (6%)	18	43
1	B	160/273 (59%)	157 (98%)	3 (2%)	50	67
1	C	160/273 (59%)	155 (97%)	5 (3%)	35	56
1	D	160/273 (59%)	154 (96%)	6 (4%)	29	51
All	All	639/1092 (58%)	616 (96%)	23 (4%)	31	53

All (23) residues with a non-rotameric sidechain are listed below:

Mol	Chain	Res	Type
1	A	28	LEU
1	A	67	VAL
1	A	89	PHE
1	A	113	THR
1	A	175	THR
1	A	182	ILE
1	A	205	LEU
1	A	210	LEU
1	A	222	ASP
1	B	28	LEU
1	B	132	VAL
1	B	134	THR
1	C	28	LEU
1	C	60	LEU
1	C	113	THR
1	C	197	MET
1	C	202	ILE
1	D	14	ASN
1	D	28	LEU
1	D	60	LEU
1	D	63	ARG
1	D	143	VAL
1	D	145	LEU

Sometimes sidechains can be flipped to improve hydrogen bonding and reduce clashes. All (6) such sidechains are listed below:

Mol	Chain	Res	Type
1	A	155	GLN
1	A	184	GLN
1	B	155	GLN
1	B	164	GLN

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Mol	Chain	Res	Type
1	C	155	GLN
1	D	155	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 5 ligands modelled in this entry, 5 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 ⓘ

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	223/355 (62%)	0.50	16 (7%) 21 20	106, 142, 178, 180	0
1	B	231/355 (65%)	0.38	11 (4%) 35 29	106, 142, 196, 214	0
1	C	234/355 (65%)	0.38	16 (6%) 23 22	106, 147, 203, 219	0
1	D	225/355 (63%)	0.46	16 (7%) 22 21	106, 142, 178, 187	0
All	All	913/1420 (64%)	0.43	59 (6%) 25 23	106, 143, 180, 219	0

All (59) RSRZ outliers are listed below:

Mol	Chain	Res	Type	RSRZ
1	A	229	LEU	6.6
1	A	228	GLN	5.7
1	A	230	VAL	5.7
1	D	230	VAL	5.5
1	A	232	ALA	5.0
1	A	225	ARG	5.0
1	A	231	ALA	4.8
1	A	233	VAL	4.7
1	A	224	VAL	4.3
1	B	68	VAL	4.0
1	B	67	VAL	3.7
1	A	226	ASN	3.7
1	C	237	GLN	3.6
1	C	239	LEU	3.4
1	B	119	GLY	3.4
1	C	227	TRP	3.4
1	C	8	ARG	3.3
1	A	11	ALA	3.3
1	A	227	TRP	3.2
1	D	134	THR	3.2
1	A	65	ALA	3.1

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Mol	Chain	Res	Type	RSRZ
1	D	67	VAL	3.0
1	C	67	VAL	3.0
1	C	163	PRO	2.9
1	D	9	ILE	2.8
1	A	180	ASP	2.7
1	B	134	THR	2.7
1	D	91	LEU	2.7
1	D	157	GLU	2.6
1	D	113	THR	2.6
1	B	70	ASP	2.6
1	A	93	GLY	2.5
1	C	179	GLY	2.5
1	D	10	TYR	2.5
1	B	229	LEU	2.5
1	C	238	LYS	2.5
1	B	66	GLY	2.4
1	C	13	LEU	2.4
1	C	90	LEU	2.4
1	D	11	ALA	2.4
1	A	115	PHE	2.4
1	D	153	ASP	2.4
1	C	231	ALA	2.3
1	A	134	THR	2.3
1	C	226	ASN	2.3
1	B	237	GLN	2.3
1	D	227	TRP	2.2
1	B	65	ALA	2.2
1	D	133	THR	2.2
1	D	179	GLY	2.2
1	B	218	VAL	2.2
1	C	7	LEU	2.1
1	C	218	VAL	2.1
1	C	89	PHE	2.1
1	B	232	ALA	2.1
1	C	15	ALA	2.1
1	D	61	LEU	2.0
1	D	231	ALA	2.0
1	D	229	LEU	2.0

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

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](#)

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($\text{\AA}^2$)	Q<0.9
2	K	B	356	1/1	0.56	0.56	4,4,4,4	1
2	K	C	357	1/1	0.93	0.10	56,56,56,56	0
2	K	A	357	1/1	0.97	0.06	34,34,34,34	0
2	K	A	356	1/1	0.98	0.20	4,4,4,4	1
2	K	C	356	1/1	0.99	0.17	76,76,76,76	0

6.5 Other polymers [i](#)

There are no such residues in this entry.