



Full wwPDB X-ray Structure Validation Report ⓘ

Mar 5, 2026 – 03:12 PM UTC

PDB ID : 4O69 / pdb_00004o69
Title : Human cyclic GMP-AMP synthase (cGAS) in complex with sulfate ion
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Deposited on : 2013-12-20
Resolution : 2.25 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

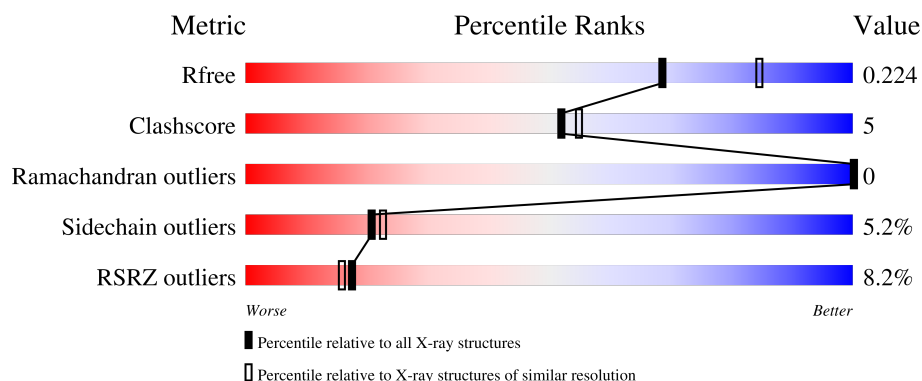
1 Overall quality at a glance

The following experimental techniques were used to determine the structure:

X-RAY DIFFRACTION

The reported resolution of this entry is 2.25 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	1898 (2.26-2.26)
Clashscore	190562	2005 (2.26-2.26)
Ramachandran outliers	187476	1965 (2.26-2.26)
Sidechain outliers	187428	1966 (2.26-2.26)
RSRZ outliers	180081	1898 (2.26-2.26)

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	363	8% 82% 14% ..

2 Entry composition [i](#)

There are 4 unique types of molecules in this entry. The entry contains 3098 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 Cyclic GMP-AMP synthase.

Mol	Chain	Residues	Atoms					ZeroOcc	AltConf	Trace
			Total	C	N	O	S			
1	A	353	2913	1863	504	530	16	0	0	0

There is a discrepancy between the modelled and reference sequences:

Chain	Residue	Modelled	Actual	Comment	Reference
A	160	MET	-	expression tag	UNP Q8N884

- Molecule 2 is ZINC ION (CCD ID: ZN) (formula: Zn).

Mol	Chain	Residues	Atoms		ZeroOcc	AltConf
2	A	1	Total	Zn	0	0
			1	1		

- Molecule 3 is SULFATE ION (CCD ID: SO4) (formula: O₄S).



Mol	Chain	Residues	Atoms			ZeroOcc	AltConf
3	A	1	Total	O	S	0	0
			5	4	1		
3	A	1	Total	O	S	0	0
			5	4	1		
3	A	1	Total	O	S	0	0
			5	4	1		

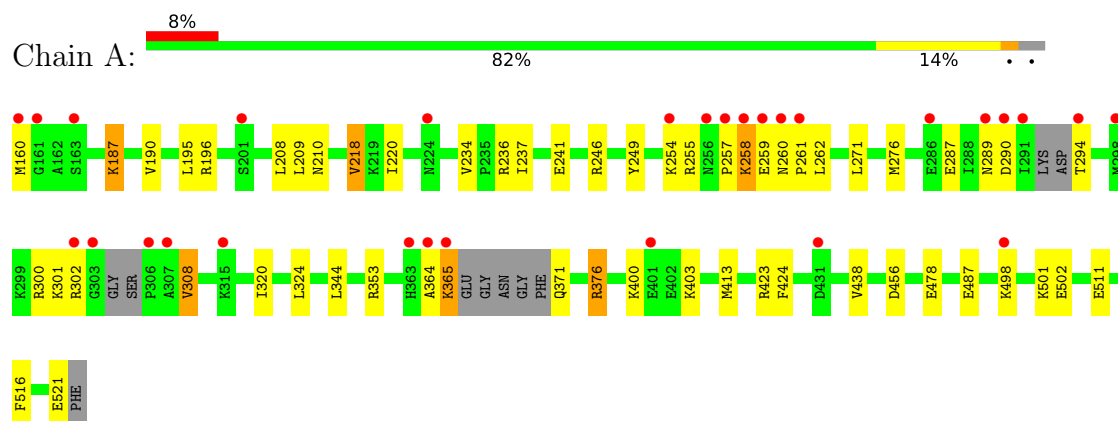
- Molecule 4 is water.

Mol	Chain	Residues	Atoms		ZeroOcc	AltConf
4	A	169	Total	O	0	0
			169	169		

3 Residue-property plots [i](#)

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: Cyclic GMP-AMP synthase



4 Data and refinement statistics

Property	Value	Source
Space group	P 61 2 2	Depositor
Cell constants a, b, c, α , β , γ	101.03Å 101.03Å 241.33Å 90.00° 90.00° 120.00°	Depositor
Resolution (Å)	33.07 – 2.25 33.07 – 2.25	Depositor EDS
% Data completeness (in resolution range)	99.1 (33.07-2.25) 99.1 (33.07-2.25)	Depositor EDS
R_{merge}	(Not available)	Depositor
R_{sym}	(Not available)	Depositor
$\langle I/\sigma(I) \rangle$ ¹	2.50 (at 2.24Å)	Xtriage
Refinement program	PHENIX (phenix.refine: 1.8.2_1309)	Depositor
R, R_{free}	0.190 , 0.224 0.193 , 0.224	Depositor DCC
R_{free} test set	1756 reflections (4.97%)	wwPDB-VP
Wilson B-factor (Å ²)	48.1	Xtriage
Anisotropy	0.384	Xtriage
Bulk solvent k_{sol} (e/Å ³), B_{sol} (Å ²)	0.33 , 50.0	EDS
L-test for twinning ²	$\langle L \rangle = 0.50$, $\langle L^2 \rangle = 0.33$	Xtriage
Estimated twinning fraction	No twinning to report.	Xtriage
F_o, F_c correlation	0.96	EDS
Total number of atoms	3098	wwPDB-VP
Average B, all atoms (Å ²)	59.0	wwPDB-VP

Xtriage's analysis on translational NCS is as follows: *The largest off-origin peak in the Patterson function is 3.07% 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](#)

Bond lengths and bond angles in the following residue types are not validated in this section: ZN, SO4

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	0.50	0/2968	0.79	2/3975 (0.1%)

There are no bond length outliers.

All (2) bond angle outliers are listed below:

Mol	Chain	Res	Type	Atoms	Z	Observed(°)	Ideal(°)
1	A	344	LEU	N-CA-C	-8.89	95.92	109.79
1	A	218	VAL	CB-CA-C	7.61	118.23	110.70

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	2913	0	2964	30	0
2	A	1	0	0	0	0
3	A	15	0	0	0	0
4	A	169	0	0	6	0
All	All	3098	0	2964	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 5.

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:A:294:THR:N	4:A:857:HOH:O	2.21	0.74
1:A:210:ASN:OD1	4:A:805:HOH:O	2.08	0.71
1:A:300:ARG:HD3	1:A:301:LYS:H	1.55	0.69
1:A:289:ASN:ND2	4:A:833:HOH:O	2.27	0.66
1:A:376:ARG:NH1	4:A:734:HOH:O	2.25	0.59
1:A:271:LEU:HD21	1:A:276:MET:HE1	1.84	0.58
1:A:365:LYS:HZ3	1:A:371:GLN:HB2	1.69	0.58
1:A:423:ARG:HD2	1:A:424:PHE:CE2	2.40	0.56
1:A:246:ARG:HG3	1:A:487:GLU:HB2	1.88	0.55
1:A:478:GLU:OE2	1:A:501:LYS:NZ	2.39	0.53
1:A:236:ARG:HB3	1:A:254:LYS:HB2	1.92	0.52
1:A:196:ARG:HG2	1:A:287:GLU:HB2	1.94	0.48
1:A:258:LYS:HD3	1:A:259:GLU:H	1.79	0.48
1:A:376:ARG:HD2	4:A:734:HOH:O	2.14	0.48
1:A:498:LYS:HD2	1:A:498:LYS:HA	1.69	0.47
1:A:308:VAL:HG22	1:A:320:ILE:HB	1.97	0.46
1:A:260:ASN:HD22	1:A:261:PRO:HD2	1.80	0.45
1:A:234:VAL:HG21	1:A:324:LEU:HD22	1.99	0.45
1:A:413:MET:HB3	1:A:438:VAL:HG13	1.99	0.44
1:A:365:LYS:NZ	1:A:371:GLN:HB2	2.32	0.43
1:A:511:GLU:HG3	1:A:516:PHE:HA	2.01	0.43
1:A:187:LYS:HD3	1:A:187:LYS:HA	1.90	0.43
1:A:353:ARG:NH1	4:A:868:HOH:O	2.51	0.42
1:A:364:ALA:O	1:A:371:GLN:HG3	2.20	0.42
1:A:300:ARG:HD3	1:A:301:LYS:N	2.30	0.42
1:A:400:LYS:HA	1:A:403:LYS:HD3	2.02	0.42
1:A:498:LYS:HE3	1:A:502:GLU:HG3	2.03	0.41
1:A:241:GLU:HA	1:A:249:TYR:CD2	2.56	0.40
1:A:255:ARG:C	1:A:257:PRO:HD3	2.46	0.40
1:A:234:VAL:HB	1:A:237:ILE:HD11	2.03	0.40

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	345/363 (95%)	336 (97%)	9 (3%)	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	328/335 (98%)	311 (95%)	17 (5%)	21	22

All (17) residues with a non-rotameric sidechain are listed below:

Mol	Chain	Res	Type
1	A	160	MET
1	A	187	LYS
1	A	190	VAL
1	A	195	LEU
1	A	208	LEU
1	A	209	LEU
1	A	218	VAL
1	A	220	ILE
1	A	258	LYS
1	A	262	LEU
1	A	290	ASP
1	A	302	ARG
1	A	308	VAL
1	A	365	LYS
1	A	376	ARG
1	A	456	ASP
1	A	521	GLU

Sometimes sidechains can be flipped to improve hydrogen bonding and reduce clashes. All (1) such sidechains are listed below:

Mol	Chain	Res	Type
1	A	419	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 4 ligands modelled in this entry, 1 is monoatomic - leaving 3 for Mogul analysis.

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	$\# Z > 2$
3	SO4	A	602	-	4,4,4	0.23	0	6,6,6	0.19	0
3	SO4	A	604	-	4,4,4	0.25	0	6,6,6	0.05	0
3	SO4	A	603	-	4,4,4	0.25	0	6,6,6	0.08	0

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

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

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	353/363 (97%)	0.31	29 (8%) 17 16	30, 56, 98, 141	0

All (29) RSRZ outliers are listed below:

Mol	Chain	Res	Type	RSRZ
1	A	303	GLY	7.6
1	A	291	ILE	6.3
1	A	365	LYS	5.8
1	A	258	LYS	5.0
1	A	257	PRO	4.9
1	A	160	MET	4.5
1	A	256	ASN	4.3
1	A	290	ASP	3.6
1	A	306	PRO	3.6
1	A	260	ASN	3.3
1	A	315	LYS	3.1
1	A	401	GLU	3.0
1	A	294	THR	3.0
1	A	307	ALA	2.8
1	A	224	ASN	2.7
1	A	261	PRO	2.6
1	A	431	ASP	2.4
1	A	363	HIS	2.4
1	A	289	ASN	2.4
1	A	302	ARG	2.4
1	A	498	LYS	2.3
1	A	163	SER	2.3
1	A	364	ALA	2.2
1	A	286	GLU	2.2
1	A	201	SER	2.2
1	A	259	GLU	2.1
1	A	254	LYS	2.1

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Mol	Chain	Res	Type	RSRZ
1	A	161	GLY	2.1
1	A	298	MET	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](#)

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
3	SO4	A	604	5/5	0.62	0.11	130,133,136,136	0
3	SO4	A	603	5/5	0.77	0.14	117,122,125,126	0
3	SO4	A	602	5/5	0.93	0.07	65,82,87,88	0
2	ZN	A	601	1/1	0.99	0.02	40,40,40,40	0

6.5 Other polymers [i](#)

There are no such residues in this entry.