Full wwPDB X-ray Structure Validation Report (i)

Apr 21, 2026 – 12:12 PM EDT

PDB ID	:	9ZEF / pdb_00009zef
Title	:	QatB-QatC complex in qatABCD anti-phage defense
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Deposited on	:	2025-11-29
Resolution	:	1.55 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 (i) 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 (i)) were used in the production of this report:

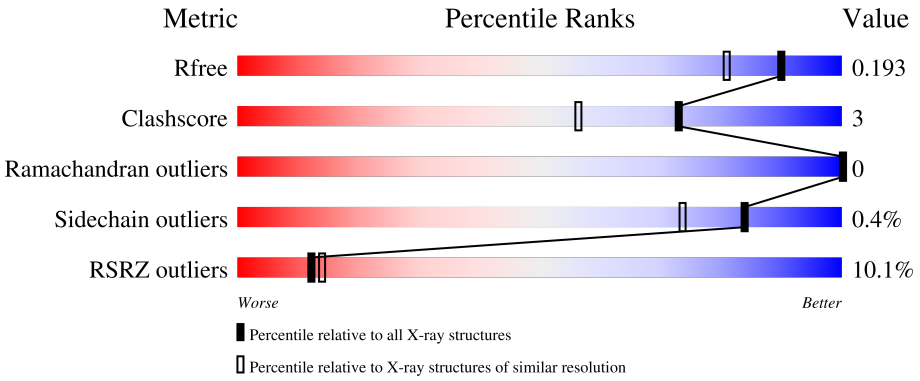
MolProbity	:	4-5-2 with Phenix2.0
Xtriage (Phenix)	:	2.0
EDS	:	3.0
Percentile statistics	:	20250101.v01 (using entries in the PDB archive January 1st 2025)
CCP4	:	9.0.010 (Gargrove)
Density-Fitness	:	1.0.12
Ideal geometry (proteins)	:	Engh & Huber (2001)
Ideal geometry (DNA, RNA)	:	Parkinson et al. (1996)
Validation Pipeline (wwPDB-VP)	:	2.49

1 Overall quality at a glance (i)

The following experimental techniques were used to determine the structure:
X-RAY DIFFRACTION

The reported resolution of this entry is 1.55 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	2145 (1.56-1.56)
Clashscore	190562	2189 (1.56-1.56)
Ramachandran outliers	187476	2153 (1.56-1.56)
Sidechain outliers	187428	2150 (1.56-1.56)
RSRZ outliers	180081	2146 (1.56-1.56)

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 <=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	287	6% 71% · 25%
2	B	466	10% 86% 6% 8%

2 Entry composition (i)

There are 4 unique types of molecules in this entry. The entry contains 5542 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 QatB.

Mol	Chain	Residues	Atoms					ZeroOcc	AltConf	Trace
1	A	215	Total	C	N	O	S	0	0	0
			1591	978	289	318	6			

- Molecule 2 is a protein called QatC.

Mol	Chain	Residues	Atoms					ZeroOcc	AltConf	Trace
2	B	431	Total	C	N	O	S	0	0	0
			3358	2108	600	633	17			

- Molecule 3 is ZINC ION (CCD ID: ZN) (formula: Zn).

Mol	Chain	Residues	Atoms		ZeroOcc	AltConf
3	B	1	Total	Zn	0	0
			1	1		

- Molecule 4 is water.

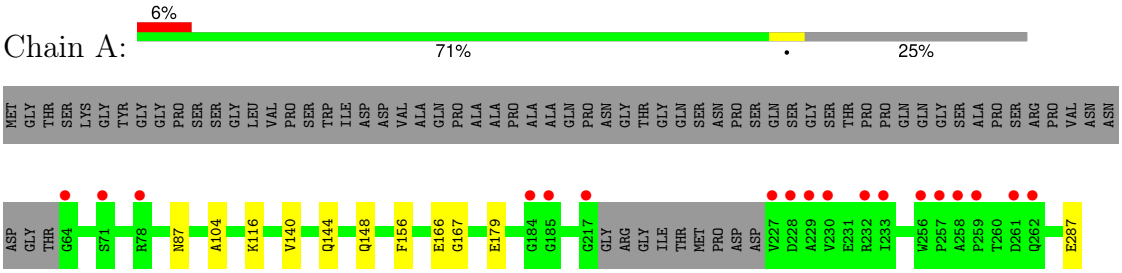
Mol	Chain	Residues	Atoms		ZeroOcc	AltConf
4	A	172	Total	O	0	0
			172	172		
4	B	420	Total	O	0	0
			420	420		

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.

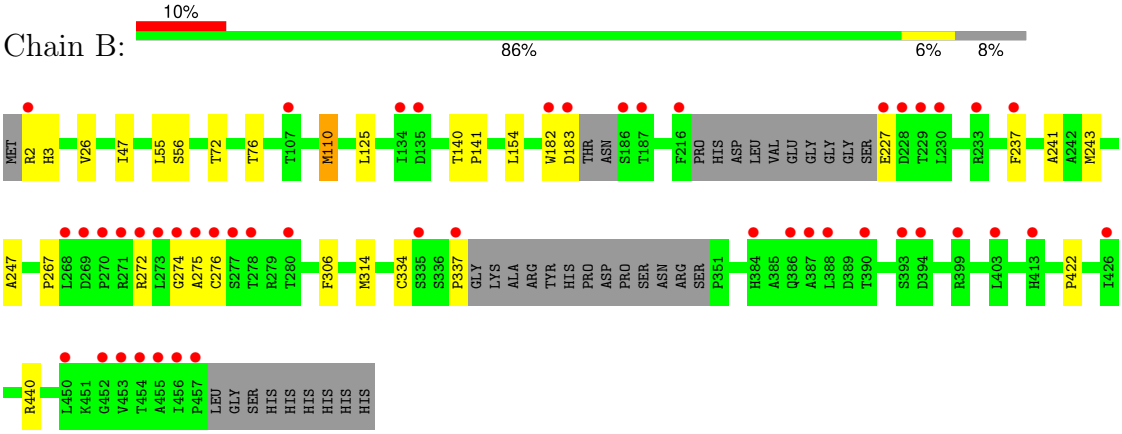
- Molecule 1: QatB

Chain A:



- Molecule 2: QatC

Chain B:



4 Data and refinement statistics (i)

Property	Value	Source
Space group	P 21 21 21	Depositor
Cell constants a, b, c, α, β, γ	70.89Å 74.61Å 133.63Å 90.00° 90.00° 90.00°	Depositor
Resolution (Å)	51.39 – 1.55 51.39 – 1.55	Depositor EDS
% Data completeness (in resolution range)	100.0 (51.39-1.55) 99.9 (51.39-1.55)	Depositor EDS
R_{merge}	0.07	Depositor
R_{sym}	(Not available)	Depositor
$< I/\sigma(I) >$ [1]	1.88 (at 1.55Å)	Xtriage
Refinement program	PHENIX 1.21.2_5419	Depositor
R, R_{free}	0.177 , 0.193 0.177 , 0.193	Depositor DCC
R_{free} test set	5281 reflections (4.90%)	wwPDB-VP
Wilson B-factor (Å^2)	22.1	Xtriage
Anisotropy	0.321	Xtriage
Bulk solvent k_{sol}(e/Å^3), B_{sol}(Å^2)	0.36 , 42.2	EDS
L-test for twinning[2]	$< \|L\| > = 0.49$, $< L^2 > = 0.32$	Xtriage
Estimated twinning fraction	0.017 for k,h,-l	Xtriage
F_o,F_c correlation	0.97	EDS
Total number of atoms	5542	wwPDB-VP
Average B, all atoms (Å^2)	31.0	wwPDB-VP

Xtriage's analysis on translational NCS is as follows: *The largest off-origin peak in the Patterson function is 5.08% of the height of the origin peak. No significant pseudotranslation is detected.*

[1] Intensities estimated from amplitudes.

[2] Theoretical values of $< |L| >$, $< L^2 >$ 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: ZN

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	0.44	0/1609	0.57	0/2170
2	B	0.50	0/3427	0.67	0/4648
All	All	0.48	0/5036	0.64	0/6818

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

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	1591	0	1566	8	0
2	B	3358	0	3300	24	0
3	B	1	0	0	0	0
4	A	172	0	0	3	3
4	B	420	0	0	5	4
All	All	5542	0	4866	31	4

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 (31) 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:179:GLU:HG3	4:A:351:HOH:O	1.83	0.78
2:B:154:LEU:HD22	2:B:237:PHE:CE1	2.26	0.70
2:B:154:LEU:HD21	2:B:241:ALA:HB2	1.72	0.70
1:A:144:GLN:NE2	1:A:148:GLN:HG2	2.10	0.66
1:A:167:GLY:HA2	2:B:275:ALA:HB3	1.81	0.63
2:B:72:THR:HG21	2:B:182:TRP:HH2	1.66	0.60
2:B:72:THR:CG2	2:B:182:TRP:HH2	2.21	0.53
2:B:306:PHE:CD2	2:B:314:MET:HE3	2.44	0.52
2:B:55:LEU:HB3	2:B:247:ALA:HB1	1.91	0.51
2:B:154:LEU:HD22	2:B:237:PHE:CD1	2.48	0.49
2:B:276:CYS:HA	4:B:866:HOH:O	2.11	0.49
2:B:272:ARG:HG3	4:B:793:HOH:O	2.12	0.48
1:A:166:GLU:CD	4:A:308:HOH:O	2.56	0.48
2:B:183:ASP:C	4:B:601:HOH:O	2.56	0.47
2:B:3:HIS:HB2	4:B:834:HOH:O	2.14	0.46
2:B:72:THR:HG21	2:B:182:TRP:CH2	2.47	0.46
2:B:47:ILE:HG13	2:B:243:MET:HE1	1.99	0.44
2:B:72:THR:O	2:B:76:THR:HG23	2.17	0.44
2:B:440:ARG:HD3	4:B:603:HOH:O	2.16	0.44
2:B:334:CYS:O	2:B:337:PRO:HD3	2.18	0.44
2:B:275:ALA:HA	2:B:422:PRO:HA	2.00	0.43
1:A:104:ALA:HB1	4:A:360:HOH:O	2.18	0.43
2:B:140:THR:HA	2:B:141:PRO:HD3	1.91	0.43
1:A:116:LYS:HD3	1:A:156:PHE:O	2.20	0.42
2:B:110:MET:HE2	2:B:110:MET:HB2	1.86	0.42
1:A:140:VAL:HG23	1:A:144:GLN:CD	2.45	0.41
2:B:2:ARG:HE	2:B:26:VAL:HG21	1.84	0.41
1:A:87:ASN:ND2	1:A:287:GLU:HG2	2.36	0.41
2:B:56:SER:HB3	2:B:141:PRO:HD3	2.03	0.41
2:B:267:PRO:CG	2:B:274:GLY:HA2	2.51	0.40
2:B:125:LEU:HD22	2:B:125:LEU:N	2.36	0.40

All (4) symmetry-related close contacts are listed below. The label for Atom-2 includes the symmetry operator and encoded unit-cell translations to be applied.

Atom-1	Atom-2	Interatomic distance (Å)	Clash overlap (Å)
4:A:355:HOH:O	4:B:914:HOH:O[4_445]	1.93	0.27
4:A:440:HOH:O	4:B:605:HOH:O[1_455]	2.12	0.08
4:A:384:HOH:O	4:B:672:HOH:O[4_445]	2.16	0.04
4:B:606:HOH:O	4:B:912:HOH:O[4_555]	2.19	0.01

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	211/287 (74%)	208 (99%)	3 (1%)	0	100	100
2	B	423/466 (91%)	413 (98%)	10 (2%)	0	100	100
All	All	634/753 (84%)	621 (98%)	13 (2%)	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	163/217 (75%)	163 (100%)	0	100	100
2	B	363/392 (93%)	361 (99%)	2 (1%)	78	64
All	All	526/609 (86%)	524 (100%)	2 (0%)	84	73

All (2) residues with a non-rotameric sidechain are listed below:

Mol	Chain	Res	Type
2	B	110	MET
2	B	227	GLU

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

Mol	Chain	Res	Type
1	A	87	ASN

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Mol	Chain	Res	Type
1	A	144	GLN
1	A	255	GLN
2	B	40	GLN
2	B	180	HIS
2	B	317	GLN
2	B	397	HIS

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

Of 1 ligands modelled in this entry, 1 is 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

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, 95^{th} 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	215/287 (74%)	0.55	18 (8%)	17	19	15, 29, 65, 87	0
2	B	431/466 (92%)	0.35	47 (10%)	10	12	15, 25, 56, 75	0
All	All	646/753 (85%)	0.42	65 (10%)	12	14	15, 26, 59, 87	0

All (65) RSRZ outliers are listed below:

Mol	Chain	Res	Type	RSRZ
1	A	227	VAL	7.3
1	A	230	VAL	5.6
2	B	270	PRO	5.5
2	B	182	TRP	5.1
1	A	229	ALA	5.1
1	A	256	TRP	4.6
1	A	185	GLY	4.6
1	A	259	PRO	4.3
2	B	237	PHE	4.3
2	B	456	ILE	4.1
1	A	257	PRO	4.1
2	B	276	CYS	4.1
2	B	273	LEU	4.1
2	B	337	PRO	4.1
2	B	274	GLY	4.0
2	B	216	PHE	4.0
2	B	390	THR	3.9
2	B	277	SER	3.8
2	B	268	LEU	3.7
2	B	413	HIS	3.6
2	B	387	ALA	3.5
2	B	227	GLU	3.4
2	B	230	LEU	3.4
2	B	450	LEU	3.3

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Mol	Chain	Res	Type	RSRZ
2	B	228	ASP	3.2
2	B	275	ALA	3.2
1	A	258	ALA	3.2
2	B	269	ASP	3.1
2	B	393	SER	3.1
2	B	452	GLY	3.1
1	A	232	ARG	3.0
2	B	183	ASP	2.9
2	B	399	ARG	2.9
2	B	455	ALA	2.9
1	A	217	GLY	2.8
2	B	388	LEU	2.8
2	B	457	PRO	2.8
2	B	453	VAL	2.7
2	B	280	THR	2.6
2	B	233	ARG	2.5
2	B	229	THR	2.5
1	A	262	GLN	2.4
2	B	335	SER	2.4
2	B	454	THR	2.4
1	A	71	SER	2.4
2	B	272	ARG	2.4
1	A	184	GLY	2.4
2	B	134	ILE	2.4
2	B	426	ILE	2.4
2	B	2	ARG	2.4
2	B	271	ARG	2.4
1	A	228	ASP	2.3
2	B	186	SER	2.3
1	A	261	ASP	2.2
2	B	135	ASP	2.2
2	B	187	THR	2.2
2	B	403	LEU	2.1
1	A	64	GLY	2.1
1	A	233	ILE	2.1
2	B	386	GLN	2.1
2	B	394	ASP	2.1
1	A	78	ARG	2.1
2	B	107	THR	2.1
2	B	384	HIS	2.1
2	B	278	THR	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, 95^{th} 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
3	ZN	B	501	1/1	0.96	0.06	26,26,26,26	0

6.5 Other polymers (i)

There are no such residues in this entry.