



Full wwPDB X-ray Structure Validation Report ⓘ

Mar 5, 2026 – 06:08 PM UTC

PDB ID : 5IQ8 / pdb_00005iq8
Title : Crystal structure of TEM1 beta-lactamase mutant A224C/G283C disulfide
Authors : Roose, B.W.; Dmochowski, I.J.
Deposited on : 2016-03-10
Resolution : 2.06 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

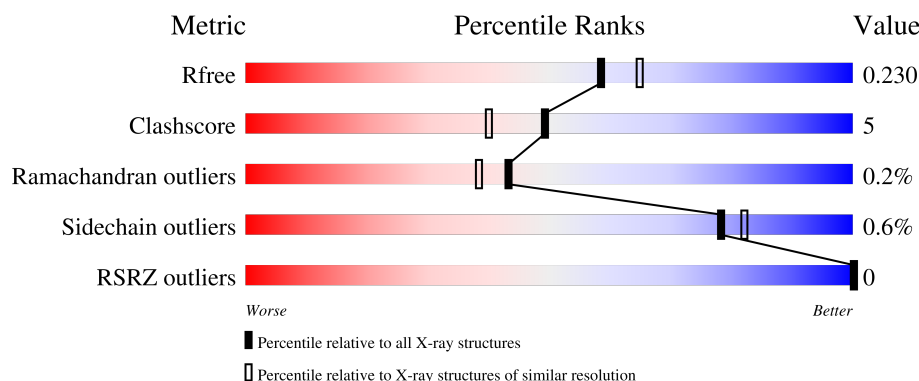
1 Overall quality at a glance

The following experimental techniques were used to determine the structure:

X-RAY DIFFRACTION

The reported resolution of this entry is 2.06 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	3774 (2.08-2.04)
Clashscore	190562	3883 (2.08-2.04)
Ramachandran outliers	187476	3860 (2.08-2.04)
Sidechain outliers	187428	3860 (2.08-2.04)
RSRZ outliers	180081	3775 (2.08-2.04)

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	263	91% 9%
1	B	263	86% 13%
1	C	263	92% 6%
1	D	263	89% 10%

2 Entry composition

There are 2 unique types of molecules in this entry. The entry contains 8835 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 Beta-lactamase TEM.

Mol	Chain	Residues	Atoms					ZeroOcc	AltConf	Trace
1	A	263	Total	C	N	O	S	0	1	0
			2016	1256	357	391	12			
1	B	263	Total	C	N	O	S	0	0	0
			2013	1254	357	390	12			
1	C	263	Total	C	N	O	S	0	1	0
			2024	1261	358	393	12			
1	D	263	Total	C	N	O	S	0	0	0
			2005	1253	356	384	12			

There are 12 discrepancies between the modelled and reference sequences:

Chain	Residue	Modelled	Actual	Comment	Reference
A	182	THR	MET	engineered mutation	UNP P62593
A	224	CYS	ALA	engineered mutation	UNP P62593
A	283	CYS	GLY	engineered mutation	UNP P62593
B	182	THR	MET	engineered mutation	UNP P62593
B	224	CYS	ALA	engineered mutation	UNP P62593
B	283	CYS	GLY	engineered mutation	UNP P62593
C	182	THR	MET	engineered mutation	UNP P62593
C	224	CYS	ALA	engineered mutation	UNP P62593
C	283	CYS	GLY	engineered mutation	UNP P62593
D	182	THR	MET	engineered mutation	UNP P62593
D	224	CYS	ALA	engineered mutation	UNP P62593
D	283	CYS	GLY	engineered mutation	UNP P62593

- Molecule 2 is water.

Mol	Chain	Residues	Atoms		ZeroOcc	AltConf
2	A	217	Total	O	0	0
			217	217		
2	B	184	Total	O	0	0
			184	184		

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Mol	Chain	Residues	Atoms		ZeroOcc	AltConf
2	C	185	Total 185	O 185	0	0
2	D	191	Total 191	O 191	0	0

3 Residue-property plots

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: Beta-lactamase TEM

Chain A:  91% 9%

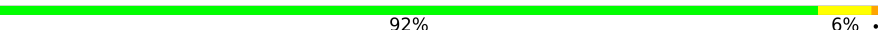


- Molecule 1: Beta-lactamase TEM

Chain B:  86% 13%



- Molecule 1: Beta-lactamase TEM

Chain C:  92% 6% .



- Molecule 1: Beta-lactamase TEM

Chain D:  89% 10%



4 Data and refinement statistics

Property	Value	Source
Space group	P 1 21 1	Depositor
Cell constants a, b, c, α , β , γ	60.86Å 84.70Å 96.34Å 90.00° 90.00° 90.00°	Depositor
Resolution (Å)	63.61 – 2.06 63.61 – 2.06	Depositor EDS
% Data completeness (in resolution range)	98.9 (63.61-2.06) 98.8 (63.61-2.06)	Depositor EDS
R_{merge}	0.13	Depositor
R_{sym}	(Not available)	Depositor
$\langle I/\sigma(I) \rangle$ ¹	2.32 (at 2.07Å)	Xtriage
Refinement program	PHENIX 1.9_1692	Depositor
R, R_{free}	0.191 , 0.241 0.178 , 0.230	Depositor DCC
R_{free} test set	3000 reflections (4.95%)	wwPDB-VP
Wilson B-factor (Å ²)	12.7	Xtriage
Anisotropy	0.914	Xtriage
Bulk solvent k_{sol} (e/Å ³), B_{sol} (Å ²)	0.36 , 30.5	EDS
L-test for twinning ²	$\langle L \rangle = 0.48$, $\langle L^2 \rangle = 0.31$	Xtriage
Estimated twinning fraction	0.466 for h,-k,-l	Xtriage
Reported twinning fraction	0.480 for h,-k,-l	Depositor
Outliers	0 of 59841 reflections	Xtriage
F_o, F_c correlation	0.97	EDS
Total number of atoms	8835	wwPDB-VP
Average B, all atoms (Å ²)	14.0	wwPDB-VP

Xtriage's analysis on translational NCS is as follows: *The analyses of the Patterson function reveals a significant off-origin peak that is 27.54 % of the origin peak, indicating pseudo-translational symmetry. The chance of finding a peak of this or larger height randomly in a structure without pseudo-translational symmetry is equal to 2.1585e-03. The detected translational NCS is most likely also responsible for the elevated intensity ratio.*

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	0.31	1/2053 (0.0%)	0.68	0/2785
1	B	0.33	0/2047	0.72	2/2777 (0.1%)
1	C	0.28	0/2063	0.68	0/2796
1	D	0.30	0/2039	0.68	2/2765 (0.1%)
All	All	0.30	1/8202 (0.0%)	0.69	4/11123 (0.0%)

All (1) bond length outliers are listed below:

Mol	Chain	Res	Type	Atoms	Z	Observed(Å)	Ideal(Å)
1	A	62	PRO	N-CD	5.62	1.55	1.47

All (4) bond angle outliers are listed below:

Mol	Chain	Res	Type	Atoms	Z	Observed(°)	Ideal(°)
1	D	144	GLY	CA-C-N	5.07	124.85	119.28
1	D	144	GLY	C-N-CA	5.07	124.85	119.28
1	B	144	GLY	CA-C-N	5.06	125.08	119.32
1	B	144	GLY	C-N-CA	5.06	125.08	119.32

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	2016	0	2000	13	0

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Mol	Chain	Non-H	H(model)	H(added)	Clashes	Symm-Clashes
1	B	2013	0	1995	46	0
1	C	2024	0	2015	12	0
1	D	2005	0	1994	16	0
2	A	217	0	0	1	0
2	B	184	0	0	3	0
2	C	185	0	0	0	0
2	D	191	0	0	2	0
All	All	8835	0	8004	87	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 (87) 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:B:271:THR:C	1:B:275:ARG:HH21	1.19	1.51
1:B:172:ALA:CB	1:B:241:ARG:NH1	1.78	1.45
1:B:172:ALA:HB1	1:B:241:ARG:NH1	1.02	1.34
1:B:271:THR:C	1:B:275:ARG:NH2	2.02	1.15
1:B:172:ALA:O	1:B:241:ARG:HD3	1.46	1.15
1:B:272:MET:N	1:B:275:ARG:HH21	1.47	1.12
1:B:172:ALA:CB	1:B:241:ARG:HH12	1.52	1.09
1:B:271:THR:CA	1:B:275:ARG:HH21	1.74	1.00
1:B:172:ALA:O	1:B:241:ARG:NH1	1.95	0.99
1:B:272:MET:N	1:B:275:ARG:NH2	2.09	0.95
1:B:172:ALA:CB	1:B:241:ARG:HH11	1.59	0.93
1:B:240:GLU:O	1:B:243:SER:OG	1.95	0.84
1:B:172:ALA:O	1:B:241:ARG:CD	2.26	0.81
1:B:271:THR:CA	1:B:275:ARG:NH2	2.40	0.81
1:B:244:ARG:NH1	1:B:276:ASN:OD1	2.16	0.79
1:C:240:GLU:N	1:C:240:GLU:OE1	2.17	0.77
1:B:271:THR:HA	1:B:275:ARG:NH2	2.00	0.76
1:B:70:SER:OG	1:B:235:SER:O	2.06	0.74
1:B:172:ALA:C	1:B:241:ARG:HH11	1.98	0.71
1:B:172:ALA:HB3	1:B:241:ARG:HH11	1.57	0.69
1:B:67:PRO:HD2	1:B:266:THR:HG21	1.75	0.69
1:B:172:ALA:CA	1:B:241:ARG:NH1	2.57	0.68
1:B:172:ALA:C	1:B:241:ARG:NH1	2.51	0.68
1:B:172:ALA:HB3	1:B:241:ARG:NH1	2.01	0.67
1:B:270:ALA:O	1:B:275:ARG:CZ	2.44	0.66
1:D:237:ALA:HB2	1:D:244:ARG:HH21	1.62	0.65

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Atom-1	Atom-2	Interatomic distance (Å)	Clash overlap (Å)
1:B:172:ALA:CA	1:B:241:ARG:HH11	2.15	0.59
1:C:237:ALA:HB2	1:C:244:ARG:HH21	1.67	0.58
1:A:48:GLU:HG3	1:A:259:ARG:HD3	1.85	0.58
1:B:172:ALA:O	1:B:241:ARG:CZ	2.52	0.57
1:B:271:THR:C	1:B:275:ARG:CZ	2.76	0.57
1:A:70:SER:OG	1:A:235:SER:O	2.23	0.56
1:B:69:MET:SD	1:B:243:SER:HB2	2.47	0.55
1:A:98:SER:OG	1:A:100:ASN:OD1	2.26	0.54
1:B:271:THR:O	1:B:275:ARG:NE	2.32	0.54
1:A:102:LEU:HD23	1:A:133:THR:HG21	1.89	0.53
1:D:48:GLU:OE2	1:D:259:ARG:NH1	2.42	0.53
1:D:49:LEU:HD21	1:D:191:ARG:HD2	1.92	0.52
1:B:91:LEU:HB3	1:B:120:ARG:HB2	1.93	0.51
1:B:102:LEU:HD11	1:B:113:LEU:HD21	1.91	0.51
1:B:102:LEU:HD23	1:B:133:THR:HG21	1.93	0.50
1:C:28:GLU:OE1	1:C:289:HIS:NE2	2.36	0.49
1:D:138:LEU:O	1:D:141:THR:OG1	2.28	0.49
1:C:220:LEU:CD1	1:C:246:ILE:HD12	2.44	0.48
1:A:220:LEU:O	1:A:223:SER:OG	2.31	0.48
1:B:174:PRO:HD3	1:B:241:ARG:HD2	1.95	0.48
1:A:288:LYS:HD3	1:A:289:HIS:NE2	2.29	0.47
1:B:32:LYS:HD2	1:B:281:GLU:HG3	1.97	0.47
1:D:259:ARG:NH2	1:D:290:TRP:O	2.47	0.47
1:B:237:ALA:HB2	1:B:244:ARG:HH21	1.78	0.47
1:D:69:MET:HE3	1:D:69:MET:HB2	1.86	0.47
1:C:102:LEU:HD11	1:C:113:LEU:HD21	1.97	0.46
1:A:111:LYS:HE2	2:A:309:HOH:O	2.15	0.46
1:C:69:MET:HE3	1:C:69:MET:HB2	1.88	0.46
1:C:26:HIS:N	1:C:58:GLU:OE1	2.49	0.46
1:B:235:SER:OG	1:B:236:GLY:N	2.48	0.46
1:A:48:GLU:HG2	1:A:57:LEU:HB2	1.99	0.45
1:A:272:MET:HE2	1:A:272:MET:HB3	1.84	0.45
1:B:146:LYS:HD2	2:D:376:HOH:O	2.16	0.45
1:D:148:LEU:HD23	1:D:162:LEU:HD22	1.99	0.45
1:A:42:ALA:HB1	1:A:266:THR:O	2.17	0.45
1:B:240:GLU:HB3	1:B:241:ARG:HG3	1.98	0.44
1:B:49:LEU:HD13	1:B:56:ILE:HD13	2.00	0.44
1:C:102:LEU:HD23	1:C:133:THR:HG21	1.99	0.44
1:D:98:SER:OG	1:D:100:ASN:N	2.49	0.43
1:D:47:ILE:HD11	1:D:62:PRO:HB3	2.00	0.43
1:B:237:ALA:HB1	2:B:327:HOH:O	2.19	0.43

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Atom-1	Atom-2	Interatomic distance (Å)	Clash overlap (Å)
1:D:126:ALA:O	1:D:130:SER:HA	2.19	0.43
1:B:225:LEU:HD23	1:B:229:TRP:HB3	2.01	0.42
1:D:67:PRO:O	1:D:69:MET:HE2	2.19	0.42
1:D:270:ALA:HB1	1:D:274:GLU:CD	2.45	0.42
1:C:152:LEU:HA	1:C:155:MET:HG2	2.01	0.42
1:A:237:ALA:HB2	1:A:244:ARG:NH2	2.35	0.41
1:B:47:ILE:HD12	1:B:56:ILE:HD12	2.02	0.41
1:B:70:SER:HB3	2:B:403:HOH:O	2.20	0.41
1:B:104:GLU:HB2	2:B:445:HOH:O	2.20	0.41
1:D:196:GLY:C	2:D:315:HOH:O	2.62	0.41
1:B:270:ALA:O	1:B:275:ARG:NH2	2.53	0.41
1:A:49:LEU:HD13	1:A:56:ILE:HG12	2.03	0.41
1:B:220:LEU:O	1:B:223:SER:OG	2.28	0.41
1:D:236:GLY:N	1:D:245:GLY:O	2.54	0.41
1:D:128:THR:HA	1:D:214:ASP:HA	2.02	0.41
1:C:67:PRO:O	1:C:69:MET:HE2	2.21	0.41
1:C:75:LEU:HD11	1:C:186:MET:HE1	2.03	0.40
1:D:76:LEU:HD21	1:D:138:LEU:HB2	2.03	0.40
1:C:200:THR:O	1:C:204:ARG:HG3	2.21	0.40
1:A:138:LEU:O	1:A:141:THR:OG1	2.31	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	262/263 (100%)	253 (97%)	9 (3%)	0	100	100
1	B	261/263 (99%)	249 (95%)	11 (4%)	1 (0%)	30	23
1	C	262/263 (100%)	256 (98%)	5 (2%)	1 (0%)	30	23
1	D	261/263 (99%)	253 (97%)	8 (3%)	0	100	100
All	All	1046/1052 (99%)	1011 (97%)	33 (3%)	2 (0%)	43	38

All (2) Ramachandran outliers are listed below:

Mol	Chain	Res	Type
1	C	220	LEU
1	B	220	LEU

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	216/219 (99%)	215 (100%)	1 (0%)	81	85
1	B	215/219 (98%)	214 (100%)	1 (0%)	81	85
1	C	218/219 (100%)	216 (99%)	2 (1%)	70	74
1	D	212/219 (97%)	211 (100%)	1 (0%)	81	85
All	All	861/876 (98%)	856 (99%)	5 (1%)	78	82

All (5) residues with a non-rotameric sidechain are listed below:

Mol	Chain	Res	Type
1	A	272	MET
1	B	28	GLU
1	C	240	GLU
1	C	244	ARG
1	D	244	ARG

Sometimes sidechains can be flipped to improve hydrogen bonding and reduce clashes. All (5) such sidechains are listed below:

Mol	Chain	Res	Type
1	A	52	ASN
1	A	88	GLN
1	A	205	GLN
1	A	276	ASN
1	B	170	ASN

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 [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	263/263 (100%)	-1.74	0 100 100	5, 13, 26, 38	1 (0%)
1	B	263/263 (100%)	-1.73	0 100 100	5, 13, 26, 53	0
1	C	263/263 (100%)	-1.74	0 100 100	6, 13, 28, 42	1 (0%)
1	D	263/263 (100%)	-1.72	0 100 100	5, 13, 24, 42	0
All	All	1052/1052 (100%)	-1.73	0 100 100	5, 13, 26, 53	2 (0%)

There are no RSRZ outliers to report.

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.