



Full wwPDB X-ray Structure Validation Report ⓘ

Mar 6, 2026 – 07:30 AM UTC

PDB ID : 6P5C / pdb_00006p5c
Title : Bacillus Fragment DNA polymerase mutant I716M
Authors : Wu, E.Y.
Deposited on : 2019-05-30
Resolution : 2.20 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

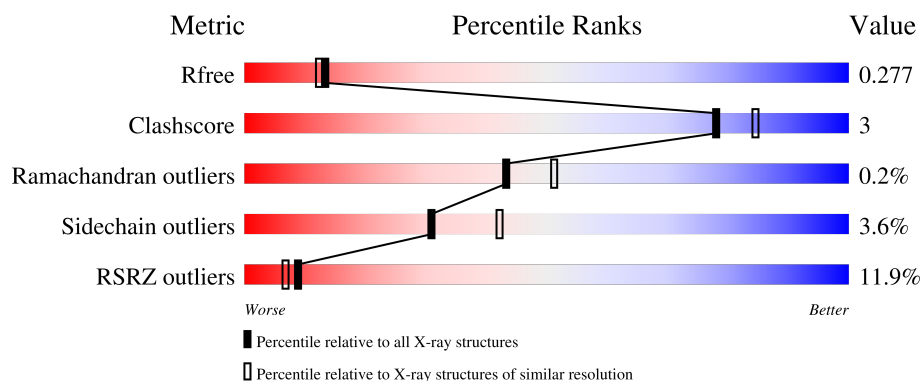
1 Overall quality at a glance

The following experimental techniques were used to determine the structure:

X-RAY DIFFRACTION

The reported resolution of this entry is 2.20 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	6164 (2.20-2.20)
Clashscore	190562	6851 (2.20-2.20)
Ramachandran outliers	187476	6768 (2.20-2.20)
Sidechain outliers	187428	6769 (2.20-2.20)
RSRZ outliers	180081	6166 (2.20-2.20)

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	B	9	11% 67% 22% 11%
2	C	9	100%
3	A	581	12% 91% 8%

2 Entry composition

There are 5 unique types of molecules in this entry. The entry contains 5188 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 DNA chain called DNA (5'-D(*CP*GP*AP*TP*CP*AP*CP*GP*C)-3').

Mol	Chain	Residues	Atoms					ZeroOcc	AltConf	Trace
1	B	9	Total	C	N	O	P	0	0	0
			179	86	34	51	8			

- Molecule 2 is a DNA chain called DNA (5'-D(P*GP*CP*GP*TP*GP*AP*TP*CP*G)-3').

Mol	Chain	Residues	Atoms					ZeroOcc	AltConf	Trace
2	C	9	Total	C	N	O	P	0	0	0
			187	88	35	55	9			

- Molecule 3 is a protein called DNA polymerase I.

Mol	Chain	Residues	Atoms					ZeroOcc	AltConf	Trace
3	A	581	Total	C	N	O	S	0	0	0
			4658	2960	808	871	19			

There are 5 discrepancies between the modelled and reference sequences:

Chain	Residue	Modelled	Actual	Comment	Reference
A	296	MET	-	initiating methionine	UNP D9N168
A	297	ALA	-	expression tag	UNP D9N168
A	598	ASP	ALA	conflict	UNP D9N168
A	713	VAL	PRO	conflict	UNP D9N168
A	716	MET	ILE	engineered mutation	UNP D9N168

- Molecule 4 is SULFATE ION (CCD ID: SO4) (formula: O₄S).



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

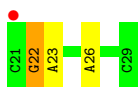
- Molecule 5 is water.

Mol	Chain	Residues	Atoms		ZeroOcc	AltConf
5	B	1	Total	O	0	0
			1	1		
5	C	8	Total	O	0	0
			8	8		
5	A	135	Total	O	0	0
			135	135		

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: DNA (5'-D(*CP*GP*AP*TP*CP*AP*CP*GP*C)-3')

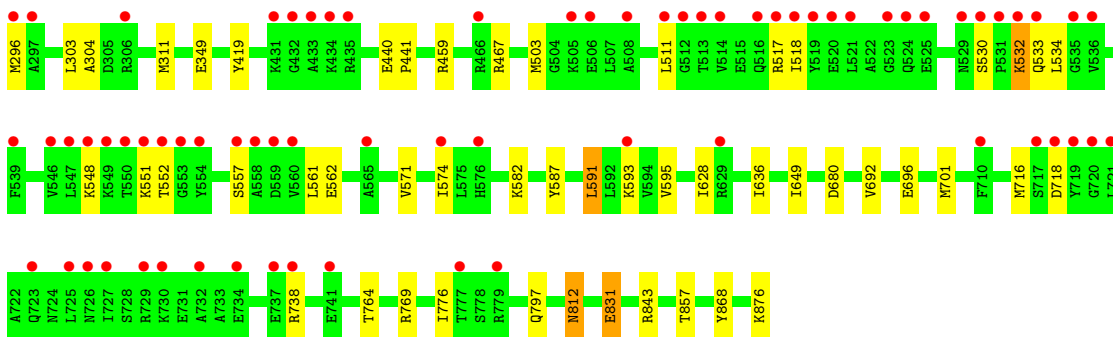


- Molecule 2: DNA (5'-D(P*GP*CP*GP*TP*GP*AP*TP*CP*G)-3')



There are no outlier residues recorded for this chain.

- Molecule 3: DNA polymerase I



4 Data and refinement statistics

Property	Value	Source
Space group	P 21 21 21	Depositor
Cell constants a, b, c, α , β , γ	88.22Å 93.52Å 105.28Å 90.00° 90.00° 90.00°	Depositor
Resolution (Å)	28.34 – 2.20 28.34 – 2.20	Depositor EDS
% Data completeness (in resolution range)	96.4 (28.34-2.20) 96.4 (28.34-2.20)	Depositor EDS
R_{merge}	(Not available)	Depositor
R_{sym}	(Not available)	Depositor
$\langle I/\sigma(I) \rangle$ ¹	2.41 (at 2.20Å)	Xtriage
Refinement program	REFMAC 5.8.0238	Depositor
R, R_{free}	0.228 , 0.273 0.234 , 0.277	Depositor DCC
R_{free} test set	2134 reflections (4.75%)	wwPDB-VP
Wilson B-factor (Å ²)	17.2	Xtriage
Anisotropy	0.358	Xtriage
Bulk solvent k_{sol} (e/Å ³), B_{sol} (Å ²)	0.36 , 27.4	EDS
L-test for twinning ²	$\langle L \rangle = 0.52$, $\langle L^2 \rangle = 0.35$	Xtriage
Estimated twinning fraction	No twinning to report.	Xtriage
F_o, F_c correlation	0.90	EDS
Total number of atoms	5188	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 5.93% 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: 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	B	0.42	0/200	0.91	2/306 (0.7%)
2	C	0.40	0/209	0.84	0/321
3	A	1.05	1/4742 (0.0%)	1.40	6/6407 (0.1%)
All	All	1.01	1/5151 (0.0%)	1.37	8/7034 (0.1%)

All (1) bond length outliers are listed below:

Mol	Chain	Res	Type	Atoms	Z	Observed(Å)	Ideal(Å)
3	A	419	TYR	C-O	5.13	1.30	1.24

All (8) bond angle outliers are listed below:

Mol	Chain	Res	Type	Atoms	Z	Observed(°)	Ideal(°)
1	B	22	DG	C2'-C3'-O3'	-6.12	102.33	111.50
3	A	857	THR	CA-CB-OG1	-5.56	101.26	109.60
1	B	22	DG	C4'-C3'-O3'	5.49	118.24	110.00
3	A	831	GLU	CB-CA-C	5.46	120.48	109.68
3	A	797	GLN	CA-C-N	5.17	125.58	119.94
3	A	797	GLN	C-N-CA	5.17	125.58	119.94
3	A	511	LEU	CA-C-N	5.01	125.50	119.94
3	A	511	LEU	C-N-CA	5.01	125.50	119.94

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	B	179	0	102	2	0
2	C	187	0	102	0	0
3	A	4658	0	4705	26	0
4	A	20	0	0	1	0
5	A	135	0	0	3	0
5	B	1	0	0	0	0
5	C	8	0	0	0	0
All	All	5188	0	4909	27	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 3.

All (27) 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)
3:A:692:VAL:HG21	3:A:701:MET:HE1	1.51	0.91
3:A:296:MET:O	3:A:296:MET:HE3	1.72	0.88
3:A:530:SER:HB2	3:A:533:GLN:HB2	1.74	0.69
3:A:587:TYR:O	3:A:591:LEU:HB2	1.94	0.66
3:A:561:LEU:O	3:A:571:VAL:HG11	2.00	0.62
3:A:591:LEU:O	3:A:595:VAL:HG23	1.99	0.61
3:A:503:MET:HE1	3:A:636:ILE:HD13	1.92	0.50
3:A:534:LEU:HD11	3:A:574:ILE:HD13	1.94	0.49
3:A:843:ARG:HD2	5:A:1127:HOH:O	2.14	0.47
3:A:304:ALA:CB	3:A:311:MET:HE1	2.44	0.47
3:A:680:ASP:OD1	3:A:680:ASP:C	2.57	0.47
3:A:692:VAL:HG21	3:A:701:MET:CE	2.35	0.46
3:A:649:ILE:O	3:A:868:TYR:HA	2.16	0.46
1:B:22:DG:H4'	1:B:23:DA:OP1	2.16	0.45
3:A:440:GLU:N	3:A:441:PRO:CD	2.79	0.45
3:A:764:THR:HA	3:A:769:ARG:O	2.17	0.45
3:A:467:ARG:NH2	5:A:1013:HOH:O	2.51	0.44
3:A:532:LYS:HD3	3:A:532:LYS:C	2.43	0.44
3:A:459:ARG:NE	3:A:459:ARG:HA	2.33	0.44
3:A:503:MET:CE	3:A:636:ILE:HD13	2.48	0.43
3:A:692:VAL:HB	3:A:696:GLU:HB2	2.00	0.43
3:A:812:ASN:ND2	5:A:1010:HOH:O	2.48	0.43
3:A:551:LYS:HD2	3:A:551:LYS:HA	1.90	0.43
3:A:296:MET:SD	4:A:903:SO4:O4	2.77	0.42

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Atom-1	Atom-2	Interatomic distance (Å)	Clash overlap (Å)
3:A:532:LYS:C	3:A:532:LYS:CD	2.92	0.42
3:A:692:VAL:CG2	3:A:701:MET:HE1	2.37	0.42
1:B:26:DA:N3	3:A:582:LYS:NZ	2.68	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
3	A	579/581 (100%)	558 (96%)	20 (4%)	1 (0%)	43 51

All (1) Ramachandran outliers are listed below:

Mol	Chain	Res	Type
3	A	628	ILE

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
3	A	496/497 (100%)	478 (96%)	18 (4%)	31 42

All (18) residues with a non-rotameric sidechain are listed below:

Mol	Chain	Res	Type
3	A	303	LEU
3	A	349	GLU
3	A	517	ARG
3	A	518	ILE
3	A	532	LYS
3	A	548	LYS
3	A	552	THR
3	A	557	SER
3	A	562	GLU
3	A	591	LEU
3	A	593	LYS
3	A	716	MET
3	A	718	ASP
3	A	738	ARG
3	A	776	ILE
3	A	812	ASN
3	A	831	GLU
3	A	876	LYS

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

Mol	Chain	Res	Type
3	A	524	GLN
3	A	529	ASN
3	A	656	GLN
3	A	704	GLN
3	A	867	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 [i](#)

4 ligands are modelled in this entry.

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	$\# Z > 2$
4	SO4	A	902	-	4,4,4	0.30	0	6,6,6	0.11	0
4	SO4	A	903	-	4,4,4	0.30	0	6,6,6	0.18	0
4	SO4	A	901	-	4,4,4	0.38	0	6,6,6	0.32	0
4	SO4	A	904	-	4,4,4	0.31	0	6,6,6	0.09	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.

1 monomer is involved in 1 short contact:

Mol	Chain	Res	Type	Clashes	Symm-Clashes
4	A	903	SO4	1	0

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	B	9/9 (100%)	0.95	1 (11%) 10 8	24, 37, 66, 87	0
2	C	9/9 (100%)	0.40	0 100 100	21, 34, 49, 56	0
3	A	581/581 (100%)	0.54	70 (12%) 9 6	12, 25, 64, 112	0
All	All	599/599 (100%)	0.54	71 (11%) 9 7	12, 25, 65, 112	0

All (71) RSRZ outliers are listed below:

Mol	Chain	Res	Type	RSRZ
3	A	719	TYR	8.2
3	A	552	THR	7.9
3	A	531	PRO	6.8
3	A	433	ALA	5.6
3	A	549	LYS	5.5
3	A	520	GLU	5.2
3	A	551	LYS	5.0
3	A	434	LYS	4.8
3	A	550	THR	4.6
3	A	432	GLY	4.4
3	A	548	LYS	4.2
1	B	21	DC	4.1
3	A	514	VAL	4.0
3	A	554	TYR	4.0
3	A	431	LYS	3.9
3	A	532	LYS	3.9
3	A	547	LEU	3.7
3	A	296	MET	3.5
3	A	519	TYR	3.5
3	A	729	ARG	3.4
3	A	523	GLY	3.4
3	A	521	LEU	3.4
3	A	560	VAL	3.3

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Mol	Chain	Res	Type	RSRZ
3	A	297	ALA	3.3
3	A	530	SER	3.3
3	A	558	ALA	3.2
3	A	720	GLY	3.2
3	A	516	GLN	3.1
3	A	553	GLY	3.1
3	A	723	GLN	3.1
3	A	525	GLU	3.0
3	A	717	SER	2.9
3	A	512	GLY	2.9
3	A	513	THR	2.9
3	A	777	THR	2.8
3	A	710	PHE	2.8
3	A	535	GLY	2.8
3	A	718	ASP	2.8
3	A	505	LYS	2.8
3	A	546	VAL	2.8
3	A	593	LYS	2.7
3	A	725	LEU	2.7
3	A	557	SER	2.7
3	A	306	ARG	2.7
3	A	466	ARG	2.7
3	A	732	ALA	2.7
3	A	511	LEU	2.6
3	A	559	ASP	2.6
3	A	779	ARG	2.6
3	A	435	ARG	2.6
3	A	539	PHE	2.5
3	A	730	LYS	2.5
3	A	518	ILE	2.4
3	A	721	LEU	2.4
3	A	536	VAL	2.4
3	A	506	GLU	2.4
3	A	576	HIS	2.4
3	A	737	GLU	2.4
3	A	524	GLN	2.4
3	A	726	ASN	2.3
3	A	517	ARG	2.3
3	A	508	ALA	2.3
3	A	738	ARG	2.3
3	A	574	ILE	2.3
3	A	741	GLU	2.2

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Mol	Chain	Res	Type	RSRZ
3	A	727	ILE	2.2
3	A	734	GLU	2.2
3	A	533	GLN	2.2
3	A	565	ALA	2.1
3	A	629	ARG	2.1
3	A	529	ASN	2.1

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
4	SO4	A	904	5/5	0.60	0.21	113,114,123,130	0
4	SO4	A	902	5/5	0.67	0.20	75,99,104,106	0
4	SO4	A	901	5/5	0.75	0.15	49,49,56,59	0
4	SO4	A	903	5/5	0.96	0.09	32,33,34,39	0

6.5 Other polymers [i](#)

There are no such residues in this entry.