



# Full wwPDB X-ray Structure Validation Report ⓘ

Feb 28, 2026 – 06:06 PM UTC

PDB ID : 8A71 / pdb\_00008a71  
Title : Crystal structure of right-handed Z-DNA containing 2'-deoxy-L-ribose in complex with the polyamine cadaverine and potassium cations at ultrahigh resolution  
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Deposited on : 2022-06-20  
Resolution : 0.69 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](mailto: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>.

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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

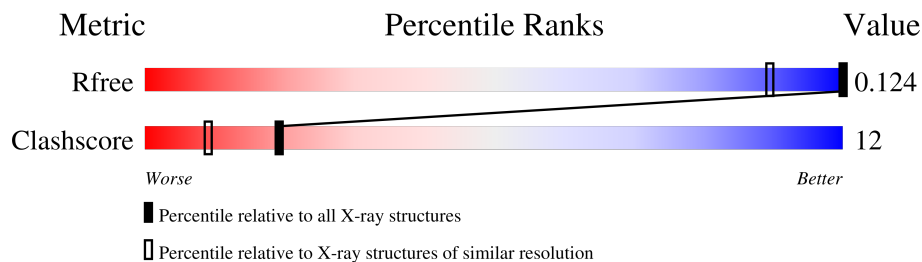
# 1 Overall quality at a glance

The following experimental techniques were used to determine the structure:

*X-RAY DIFFRACTION*



The reported resolution of this entry is 0.69 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	1423 (1.00-0.48)
Clashscore	190562	1479 (1.00-0.48)

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  $\geq 3$ , 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	6	 67%                      17%                      17%
1	B	6	 83%                      17%

## 2 Entry composition [i](#)

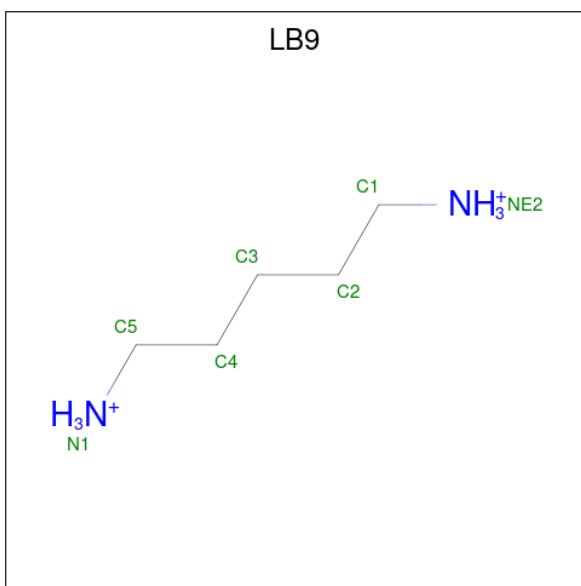
There are 4 unique types of molecules in this entry. The entry contains 424 atoms, of which 0 are hydrogens and 0 are deuteriums.

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 Right-handed Z-DNA.

Mol	Chain	Residues	Atoms					ZeroOcc	AltConf	Trace
			Total	C	N	O	P			
1	A	6	Total 138	C 60	N 24	O 46	P 8	0	4	0
1	B	6	Total 128	C 60	N 24	O 38	P 6	0	2	0

- Molecule 2 is 5-azaniumylpentylazanium (CCD ID: LB9) (formula:  $C_5H_{16}N_2$ ).



Mol	Chain	Residues	Atoms			ZeroOcc	AltConf
			Total	C	N		
2	A	1	Total 7	C 5	N 2	0	0

- Molecule 3 is POTASSIUM ION (CCD ID: K) (formula: K).

Mol	Chain	Residues	Atoms	ZeroOcc	AltConf
3	A	1	Total K 1	0	0

- Molecule 4 is water.

Mol	Chain	Residues	Atoms		ZeroOcc	AltConf
4	A	68	Total 82	O 82	0	14
4	B	53	Total 68	O 68	0	15

### 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: Right-handed Z-DNA

Chain A:  67% 17% 17%



- Molecule 1: Right-handed Z-DNA

Chain B:  83% 17%



## 4 Data and refinement statistics

Property	Value	Source
Space group	P 21 21 21	Depositor
Cell constants a, b, c, $\alpha$ , $\beta$ , $\gamma$	17.91Å 31.13Å 44.11Å 90.00° 90.00° 90.00°	Depositor
Resolution (Å)	25.43 – 0.69 25.43 – 0.69	Depositor EDS
% Data completeness (in resolution range)	96.3 (25.43-0.69) 91.9 (25.43-0.69)	Depositor EDS
$R_{merge}$	0.08	Depositor
$R_{sym}$	(Not available)	Depositor
$\langle I/\sigma(I) \rangle$ <sup>1</sup>	1.67 (at 0.70Å)	Xtrriage
Refinement program	SHELX	Depositor
R, $R_{free}$	0.105 , 0.128 0.112 , 0.124	Depositor DCC
$R_{free}$ test set	938 reflections (2.31%)	wwPDB-VP
Wilson B-factor (Å <sup>2</sup> )	4.0	Xtrriage
Anisotropy	0.365	Xtrriage
Bulk solvent $k_{sol}$ (e/Å <sup>3</sup> ), $B_{sol}$ (Å <sup>2</sup> )	0.32 , 73.2	EDS
L-test for twinning <sup>2</sup>	$\langle  L  \rangle = 0.49$ , $\langle L^2 \rangle = 0.32$	Xtrriage
Estimated twinning fraction	No twinning to report.	Xtrriage
$F_o, F_c$ correlation	0.97	EDS
Total number of atoms	424	wwPDB-VP
Average B, all atoms (Å <sup>2</sup> )	7.0	wwPDB-VP

Xtrriage's analysis on translational NCS is as follows: *The analyses of the Patterson function reveals a significant off-origin peak that is 31.98 % 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 1.0123e-03. The detected translational NCS is most likely also responsible for the elevated intensity ratio.*

<sup>1</sup>Intensities estimated from amplitudes.

<sup>2</sup>Theoretical 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: K, ODC, LB9, ODG

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).

There are no protein, RNA or DNA chains available to summarize Z scores of covalent bonds and angles.

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 [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	138	0	46	2	0
1	B	128	0	63	2	0
2	A	7	0	0	0	0
3	A	1	0	0	0	0
4	A	82	0	0	2	0
4	B	68	0	0	2	0
All	All	424	0	109	4	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 12.

All (4) 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:9[B]:0DC:OP1	4:B:101:HOH:O	1.53	1.26
1:A:6[A]:0DG:OP1	4:A:201:HOH:O	1.89	0.89
1:A:5[A]:0DC:OP2	4:A:202[A]:HOH:O	2.07	0.71
1:B:9[B]:0DC:P	4:B:101:HOH:O	2.41	0.62

There are no symmetry-related clashes.

## 5.3 Torsion angles [i](#)

### 5.3.1 Protein backbone [i](#)

There are no protein molecules in this entry.

### 5.3.2 Protein sidechains [i](#)

There are no protein molecules in this entry.

### 5.3.3 RNA [i](#)

There are no RNA molecules in this entry.

## 5.4 Non-standard residues in protein, DNA, RNA chains [i](#)

18 non-standard protein/DNA/RNA residues 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	$\# Z  > 2$
1	0DC	B	9[B]	1	17,20,21	0.47	0	23,28,31	0.44	0
1	0DC	A	1	1	17,17,21	0.57	0	24,24,31	0.38	0
1	0DG	A	4[A]	1	21,24,25	0.49	0	30,35,38	0.62	0
1	0DG	A	2	1	21,24,25	0.58	0	30,35,38	0.44	0
1	0DC	B	9[A]	1,3	17,20,21	0.48	0	23,28,31	0.44	0
1	0DC	A	3[B]	1	17,20,21	0.38	0	23,28,31	0.49	0

Mol	Type	Chain	Res	Link	Bond lengths			Bond angles		
					Counts	RMSZ	# Z  > 2	Counts	RMSZ	# Z  > 2
1	ODC	A	5[B]	1	17,20,21	0.31	0	23,28,31	0.57	0
1	ODC	B	11	1	17,20,21	0.52	0	23,28,31	0.33	0
1	ODG	A	6[A]	1,3	21,24,25	0.74	0	30,35,38	0.61	0
1	ODC	A	3[A]	1	17,20,21	0.37	0	23,28,31	0.48	0
1	ODC	A	5[A]	1	17,20,21	0.42	0	23,28,31	0.62	1 (4%)
1	ODG	A	6[B]	1,3	21,24,25	0.76	0	30,35,38	0.61	0
1	ODG	B	8[B]	1	21,24,25	0.75	0	30,35,38	0.81	0
1	ODG	B	10	1	21,24,25	0.56	0	30,35,38	0.51	0
1	ODC	B	7	1	17,17,21	0.59	0	24,24,31	0.42	0
1	ODG	B	8[A]	1	21,24,25	0.75	0	30,35,38	0.52	0
1	ODG	B	12	1	21,24,25	0.61	0	30,35,38	0.58	0
1	ODG	A	4[B]	1	21,24,25	0.48	0	30,35,38	0.70	0

In the following table, the Chirals column lists the number of chiral outliers, the number of chiral centers analysed, the number of these observed in the model and the number defined in the Chemical Component Dictionary. Similar counts are reported in the Torsion and Rings columns. '-' means no outliers of that kind were identified.

Mol	Type	Chain	Res	Link	Chirals	Torsions	Rings
1	ODC	B	9[B]	1	-	0/7/21/22	0/2/2/2
1	ODC	A	1	1	-	0/6/18/22	0/2/2/2
1	ODG	A	4[A]	1	-	0/7/21/22	0/3/3/3
1	ODG	A	2	1	-	0/7/21/22	0/3/3/3
1	ODC	B	9[A]	1,3	-	0/7/21/22	0/2/2/2
1	ODC	A	3[B]	1	-	1/7/21/22	0/2/2/2
1	ODC	A	5[B]	1	-	1/7/21/22	0/2/2/2
1	ODC	B	11	1	-	0/7/21/22	0/2/2/2
1	ODG	A	6[A]	1,3	-	2/7/21/22	0/3/3/3
1	ODC	A	3[A]	1	-	1/7/21/22	0/2/2/2
1	ODC	A	5[A]	1	-	0/7/21/22	0/2/2/2
1	ODG	A	6[B]	1,3	-	2/7/21/22	0/3/3/3
1	ODG	B	8[B]	1	-	0/7/21/22	0/3/3/3
1	ODG	B	10	1	-	0/7/21/22	0/3/3/3
1	ODC	B	7	1	-	0/6/18/22	0/2/2/2
1	ODG	B	8[A]	1	-	0/7/21/22	0/3/3/3
1	ODG	B	12	1	-	2/7/21/22	0/3/3/3
1	ODG	A	4[B]	1	-	0/7/21/22	0/3/3/3

There are no bond length outliers.

All (1) bond angle outliers are listed below:

Mol	Chain	Res	Type	Atoms	Z	Observed(°)	Ideal(°)
1	A	5[A]	0DC	O3'-C3'-C2'	-2.21	103.22	110.88

There are no chirality outliers.

All (9) torsion outliers are listed below:

Mol	Chain	Res	Type	Atoms
1	A	6[A]	0DG	C2'-C1'-N9-C4
1	A	6[B]	0DG	C2'-C1'-N9-C4
1	B	12	0DG	C2'-C1'-N9-C4
1	A	6[A]	0DG	C2'-C1'-N9-C8
1	A	6[B]	0DG	C2'-C1'-N9-C8
1	B	12	0DG	C2'-C1'-N9-C8
1	A	3[A]	0DC	C4'-C5'-O5'-P
1	A	3[B]	0DC	C4'-C5'-O5'-P
1	A	5[B]	0DC	C4'-C5'-O5'-P

There are no ring outliers.

3 monomers are involved in 4 short contacts:

Mol	Chain	Res	Type	Clashes	Symm-Clashes
1	B	9[B]	0DC	2	0
1	A	6[A]	0DG	1	0
1	A	5[A]	0DC	1	0

## 5.5 Carbohydrates [i](#)

There are no oligosaccharides in this entry.

## 5.6 Ligand geometry [i](#)

Of 2 ligands modelled in this entry, 1 is monoatomic - leaving 1 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
2	LB9	A	101	-	6,6,6	0.31	0	5,5,5	0.23	0

In the following table, the Chirals column lists the number of chiral outliers, the number of chiral centers analysed, the number of these observed in the model and the number defined in the Chemical Component Dictionary. Similar counts are reported in the Torsion and Rings columns. '-' means no outliers of that kind were identified.

Mol	Type	Chain	Res	Link	Chirals	Torsions	Rings
2	LB9	A	101	-	-	0/4/4/4	-

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 [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, 95<sup>th</sup> 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 <sup>2</sup> )	Q<0.9
1	A	0/6	-	-	-	-
1	B	0/6	-	-	-	-
All	All	0/12	-	-	-	-

There are no RSRZ outliers to report.

### 6.2 Non-standard residues in protein, DNA, RNA chains [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<sup>th</sup> 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 <sup>2</sup> )	Q<0.9
1	ODC	A	1	16/20	0.99	0.04	3,3,4,4	0
1	ODC	B	7	16/20	0.99	0.06	3,4,5,6	0
1	ODG	B	8[A]	22/23	0.99	0.05	4,4,5,6	4
1	ODG	B	8[B]	22/23	0.99	0.05	4,4,5,7	4
1	ODC	A	3[A]	19/20	0.99	0.04	3,4,6,6	1
1	ODC	A	3[B]	19/20	0.99	0.04	3,4,6,10	1
1	ODC	B	9[A]	19/20	0.99	0.05	3,4,4,5	4
1	ODC	B	9[B]	19/20	0.99	0.05	3,4,25,33	4
1	ODG	A	4[A]	22/23	0.99	0.05	3,4,5,8	6
1	ODG	A	4[B]	22/23	0.99	0.05	3,4,16,23	6
1	ODG	B	10	22/23	0.99	0.04	3,4,5,6	0
1	ODC	A	5[A]	19/20	0.99	0.04	3,4,14,15	6
1	ODC	A	5[B]	19/20	0.99	0.04	3,4,5,5	6
1	ODC	B	11	19/20	0.99	0.04	3,3,4,5	0
1	ODG	A	6[A]	22/23	0.99	0.05	4,5,6,9	5
1	ODG	A	6[B]	22/23	0.99	0.05	3,4,5,6	5
1	ODG	B	12	22/23	0.99	0.04	3,3,4,6	0
1	ODG	A	2	22/23	1.00	0.04	3,3,4,5	0

### 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<sup>th</sup> 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 <sup>2</sup> )	Q<0.9
2	LB9	A	101	7/7	0.85	0.17	8,8,10,10	7
3	K	A	102	1/1	1.00	0.01	4,4,4,4	1

### 6.5 Other polymers [i](#)

There are no such residues in this entry.