



wwPDB X-ray Structure Validation Summary Report ⓘ

Mar 9, 2026 – 05:54 AM UTC

PDB ID : 3NAO / pdb_00003nao
Title : A DNA Crystal Designed to Contain Two Molecules per Asymmetric Unit Cell
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Deposited on : 2010-06-02
Resolution : 5.03 Å(reported)

This is a wwPDB X-ray Structure Validation Summary 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

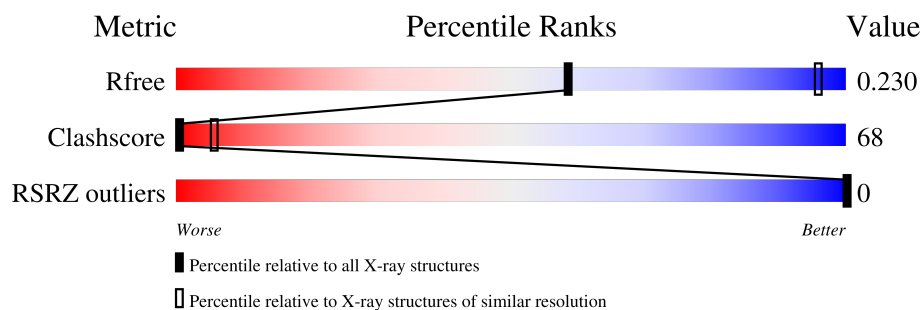
1 Overall quality at a glance

The following experimental techniques were used to determine the structure:

X-RAY DIFFRACTION

The reported resolution of this entry is 5.03 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	1017 (6.10-3.98)
Clashscore	190562	1046 (6.06-4.00)
RSRZ outliers	180081	1012 (6.10-3.98)

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	21	
2	B	7	
3	C	6	
4	D	8	
5	E	21	
6	F	7	
7	G	6	

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Mol	Chain	Length	Quality of chain
8	H	8	 100%

2 Entry composition

There are 8 unique types of molecules in this entry. The entry contains 1710 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(*GP*AP*GP*CP*AP*GP*CP*CP*TP*GP*TP*AP*CP*GP*GP*AP*CP*AP*TP*CP*A)-3').

Mol	Chain	Residues	Atoms					ZeroOcc	AltConf	Trace
1	A	21	Total	C	N	O	P	0	0	0
			429	204	84	121	20			

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

Mol	Chain	Residues	Atoms					ZeroOcc	AltConf	Trace
2	B	7	Total	C	N	O	P	0	0	0
			141	67	26	41	7			

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

Mol	Chain	Residues	Atoms					ZeroOcc	AltConf	Trace
3	C	6	Total	C	N	O	P	0	0	0
			124	58	23	37	6			

- Molecule 4 is a DNA chain called DNA (5'-D(*CP*TP*TP*GP*AP*TP*GP*T)-3').

Mol	Chain	Residues	Atoms					ZeroOcc	AltConf	Trace
4	D	8	Total	C	N	O	P	0	0	0
			161	79	26	49	7			

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

Mol	Chain	Residues	Atoms					ZeroOcc	AltConf	Trace
5	E	21	Total	C	N	O	P	0	0	0
			427	203	82	122	20			

- Molecule 6 is a DNA chain called DNA (5'-D(P*CP*CP*AP*CP*GP*CP*A)-3').

Mol	Chain	Residues	Atoms					ZeroOcc	AltConf	Trace
6	F	7	Total	C	N	O	P	0	0	0
			140	66	27	40	7			

- Molecule 7 is a DNA chain called DNA (5'-D(P*GP*GP*TP*AP*GP*G)-3').

Mol	Chain	Residues	Atoms					ZeroOcc	AltConf	Trace
7	G	6	Total	C	N	O	P	0	0	0
			129	60	27	36	6			

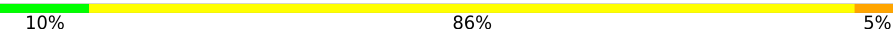
- Molecule 8 is a DNA chain called DNA (5'-D(*TP*CP*GP*TP*CP*TP*GP*T)-3').

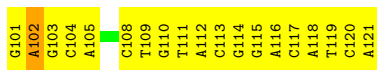
Mol	Chain	Residues	Atoms					ZeroOcc	AltConf	Trace
8	H	8	Total	C	N	O	P	0	0	0
			159	78	24	50	7			

3 Residue-property plots [i](#)

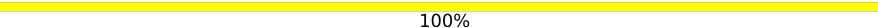
These plots are drawn for all protein, RNA, DNA and oligosaccharide chains in the entry. The first graphic for a chain summarises the proportions of the various outlier classes displayed in the second graphic. The second graphic shows the sequence view annotated by issues in geometry and electron density. 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.

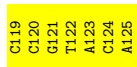
- Molecule 1: DNA (5'-D(*GP*AP*GP*CP*AP*GP*CP*CP*TP*GP*TP*AP*CP*GP*GP*AP*CP*AP*TP*CP*A)-3')

Chain A:  10% 86% 5%

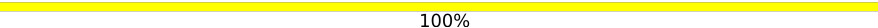


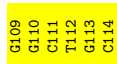
- Molecule 2: DNA (5'-D(P*CP*CP*GP*TP*AP*CP*A)-3')

Chain B:  100%

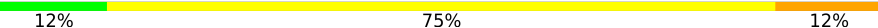


- Molecule 3: DNA (5'-D(P*GP*GP*CP*TP*GP*C)-3')

Chain C:  100%



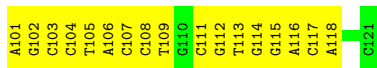
- Molecule 4: DNA (5'-D(*CP*TP*TP*GP*AP*TP*GP*T)-3')

Chain D:  12% 75% 12%



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

Chain E:  19% 81%



- Molecule 6: DNA (5'-D(P*CP*CP*AP*CP*GP*CP*A)-3')

Chain F:  100%

G119
C120
A121
C122
G123
C124
A125

- Molecule 7: DNA (5'-D(P*GP*GP*TP*AP*GP*G)-3')

Chain G:  100%

G109
G110
T111
A112
G113
G114

- Molecule 8: DNA (5'-D(*TP*CP*GP*TP*CP*TP*GP*T)-3')

Chain H:  100%

T101
C102
G103
T104
C105
T106
G107
T108

4 Data and refinement statistics

Property	Value	Source
Space group	H 3	Depositor
Cell constants a, b, c, α , β , γ	105.34Å 105.34Å 183.94Å 90.00° 90.00° 120.00°	Depositor
Resolution (Å)	34.12 – 5.03 34.12 – 5.03	Depositor EDS
% Data completeness (in resolution range)	84.9 (34.12-5.03) 86.3 (34.12-5.03)	Depositor EDS
R_{merge}	(Not available)	Depositor
R_{sym}	(Not available)	Depositor
$\langle I/\sigma(I) \rangle$ ¹	2.63 (at 5.07Å)	Xtriage
Refinement program	PHENIX (phenix.refine)	Depositor
R, R_{free}	0.191 , 0.229 0.192 , 0.230	Depositor DCC
R_{free} test set	322 reflections (10.29%)	wwPDB-VP
Wilson B-factor (Å ²)	207.0	Xtriage
Anisotropy	0.655	Xtriage
Bulk solvent k_{sol} (e/Å ³), B_{sol} (Å ²)	0.16 , 131.0	EDS
L-test for twinning ²	$\langle L \rangle = 0.49$, $\langle L^2 \rangle = 0.32$	Xtriage
Estimated twinning fraction	0.065 for h,-h-k,-l	Xtriage
F_o, F_c correlation	0.98	EDS
Total number of atoms	1710	wwPDB-VP
Average B, all atoms (Å ²)	260.0	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 68.79 % 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 4.1238e-06. 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	0.23	0/482	0.85	1/742 (0.1%)
2	B	0.21	0/157	0.72	0/239
3	C	0.24	0/138	0.93	0/211
4	D	0.23	0/179	0.94	1/275 (0.4%)
5	E	0.22	0/479	0.75	0/737
6	F	0.30	0/156	0.91	0/237
7	G	0.20	0/145	0.77	0/223
8	H	0.25	0/176	0.88	0/270
All	All	0.23	0/1912	0.83	2/2934 (0.1%)

There are no bond length outliers.

All (2) bond angle outliers are listed below:

Mol	Chain	Res	Type	Atoms	Z	Observed(°)	Ideal(°)
4	D	103	DT	O4'-C1'-N1	5.26	116.29	108.40
1	A	102	DA	O4'-C1'-N9	5.09	116.03	108.40

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	429	0	236	55	0
2	B	141	0	79	14	1
3	C	124	0	68	20	1

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Mol	Chain	Non-H	H(model)	H(added)	Clashes	Symm-Clashes
4	D	161	0	94	25	1
5	E	427	0	236	42	0
6	F	140	0	78	12	1
7	G	129	0	68	11	1
8	H	159	0	94	19	1
All	All	1710	0	953	181	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 68.

The worst 5 of 181 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:112:DA:H2'	1:A:113:DC:H6	1.01	1.07
1:A:112:DA:H2'	1:A:113:DC:C6	1.92	1.05
1:A:115:DG:H8	1:A:115:DG:OP2	1.49	0.95
4:D:101:DC:H2''	4:D:102:DT:OP1	1.70	0.92
2:B:124:DC:H2''	2:B:125:DA:H5''	1.56	0.88

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)
6:F:119:DC:OP1	6:F:125:DA:O3'[3_665]	1.84	0.36
7:G:109:DG:OP2	8:H:108:DT:O3'[2_655]	1.90	0.30
3:C:109:DG:OP2	4:D:108:DT:O3'[2_555]	1.92	0.28
2:B:119:DC:OP1	2:B:125:DA:O3'[3_555]	1.96	0.24

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](#)

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	21/21 (100%)	0.04	0 100 100	213, 276, 354, 393	0
2	B	7/7 (100%)	0.18	0 100 100	236, 261, 301, 330	0
3	C	6/6 (100%)	-0.15	0 100 100	238, 264, 295, 297	0
4	D	8/8 (100%)	0.09	0 100 100	237, 301, 415, 473	0
5	E	21/21 (100%)	-0.16	0 100 100	142, 227, 304, 315	0
6	F	7/7 (100%)	-0.04	0 100 100	140, 163, 192, 204	0
7	G	6/6 (100%)	0.13	0 100 100	245, 275, 297, 314	0
8	H	8/8 (100%)	-0.12	0 100 100	178, 212, 273, 292	0
All	All	84/84 (100%)	-0.02	0 100 100	140, 253, 354, 473	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.