W O R L D W I D E
wwPDB
P R O T E I N   D A T A   B A N K

wwPDB X-ray Structure Validation Summary Report (i)

Jan 26, 2026 – 02:21 PM EST

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PDB ID	:	9MXO / pdb_00009mxo
Title	:	Motif2-Motif1 Left-handed parallel G-quadruplex in H3 Spacegroup
Authors	:	Hendrickson, A.D.; Xing, E.R.; Yatsunyk, L.A.
Deposited on	:	2025-01-20
Resolution	:	1.68 Å(reported)

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 1.68 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	Percentile Ranks	Value
Rfree		0.204
Clashscore		2
RSRZ outliers		0

Worse   *Better*

▌ Percentile relative to all X-ray structures

▯ Percentile relative to X-ray structures of similar resolution
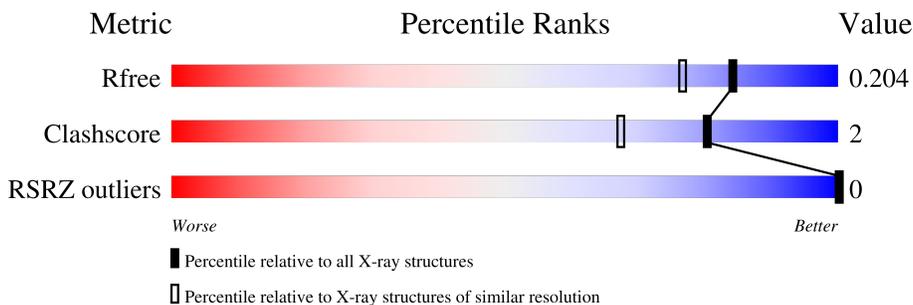
Metric	Whole archive (#Entries)	Similar resolution (#Entries, resolution range(Å))
R_{free}	164625	8422 (1.70-1.66)
Clashscore	180529	1005 (1.68-1.68)
RSRZ outliers	164620	8421 (1.70-1.66)

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	26	100%
1	B	26	77% 23%
1	C	26	85% 15%
1	D	26	96% •

WORLDWIDE
wwPDB
PROTEIN DATA BANK

2 Entity composition ⓘ

There are 7 unique types of molecules in this entry. The entry contains 2429 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 (26-MER).

Mol	Chain	Residues	Atoms					ZeroOcc	AltConf	Trace
1	A	26	Total	C	N	O	P	0	0	0
			549	260	100	164	25			
1	B	26	Total	C	N	O	P	0	0	0
			549	260	100	164	25			
1	C	26	Total	C	N	O	P	0	0	0
			549	260	100	164	25			
1	D	26	Total	C	N	O	P	0	0	0
			549	260	100	164	25			

- Molecule 2 is POTASSIUM ION (CCD ID: K) (formula: K).

Mol	Chain	Residues	Atoms		ZeroOcc	AltConf
2	A	3	Total	K	0	0
			3	3		
2	B	3	Total	K	0	0
			3	3		
2	C	3	Total	K	0	0
			3	3		
2	D	3	Total	K	0	0
			3	3		

- Molecule 3 is SPERMINE (CCD ID: SPM) (formula: $C_{10}H_{26}N_4$).
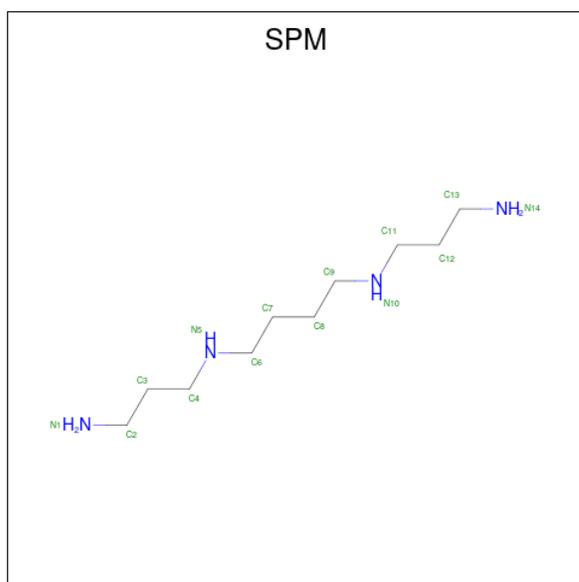
Mol	Chain	Residues	Atoms			ZeroOcc	AltConf
3	B	1	Total 14	C 10	N 4	0	0
3	B	1	Total 14	C 10	N 4	0	0

- Molecule 4 is DI(HYDROXYETHYL)ETHER (CCD ID: PEG) (formula: $C_4H_{10}O_3$).
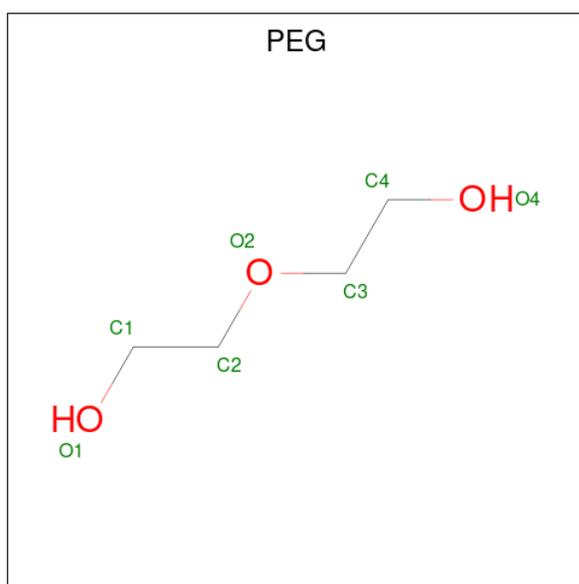
Mol	Chain	Residues	Atoms			ZeroOcc	AltConf
4	B	1	Total 7	C 4	O 3	0	0

- Molecule 5 is TETRAETHYLENE GLYCOL (CCD ID: PG4) (formula: $C_8H_{18}O_5$).

PG4
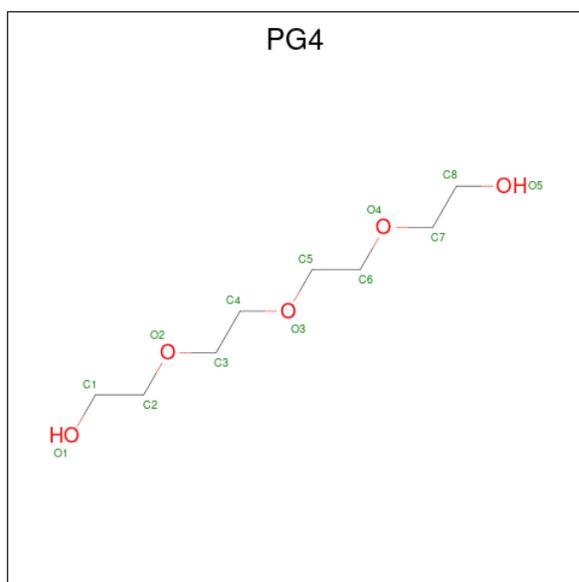
Mol	Chain	Residues	Atoms			ZeroOcc	AltConf
5	C	1	Total 13	C 8	O 5	0	0
5	C	1	Total 13	C 8	O 5	0	0

- Molecule 6 is TRIETHYLENE GLYCOL (CCD ID: PGE) (formula: $C_6H_{14}O_4$).

PGE
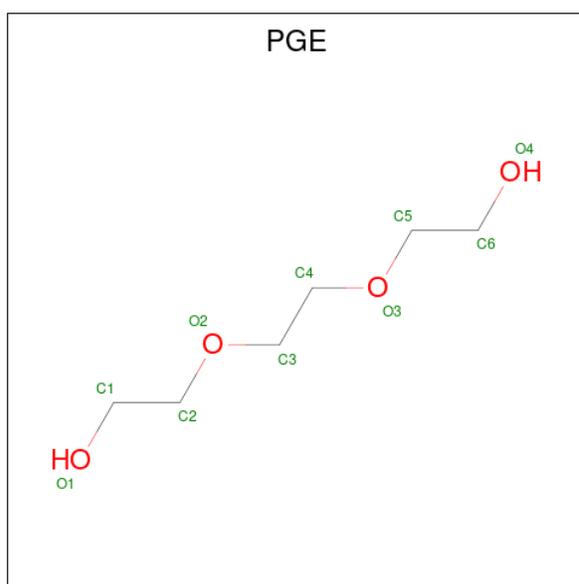
Mol	Chain	Residues	Atoms			ZeroOcc	AltConf
6	C	1	Total 10	C 6	O 4	0	0
6	D	1	Total 10	C 6	O 4	0	0

• Molecule 7 is water.

Mol	Chain	Residues	Atoms		ZeroOcc	AltConf
7	A	33	Total 33	O 33	0	0
7	B	44	Total 44	O 44	0	0
7	C	39	Total 39	O 39	0	0
7	D	24	Total 24	O 24	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: DNA (26-MER)

Chain A:

100%

There are no outlier residues recorded for this chain.

• Molecule 1: DNA (26-MER)

Chain B:

77%   23%

G1   G7 G8   G12 T13   T16   G24   T25 G26
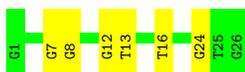
• Molecule 1: DNA (26-MER)

Chain C:

85%   15%

G1   G4 G5 T6   T14   G26

• Molecule 1: DNA (26-MER)

Chain D:

96%   •

G1   T16   G26

4 Data and refinement statistics ⓘ

Property	Value	Source
Space group	H 3	Depositor
Cell constants a, b, c, α, β, γ	104.65Å 104.65Å 65.36Å 90.00° 90.00° 120.00°	Depositor
Resolution (Å)	30.34 – 1.68 30.34 – 1.68	Depositor EDS
% Data completeness (in resolution range)	96.7 (30.34-1.68) 96.7 (30.34-1.68)	Depositor EDS
R_{merge}	0.12	Depositor
R_{sym}	(Not available)	Depositor
$< I/\sigma(I) >$ [1]	1.52 (at 1.68Å)	Xtriage
Refinement program	PHENIX (1.21.2_5419: ???)	Depositor
R, R_{free}	0.172 , 0.202 0.174 , 0.204	Depositor DCC
R_{free} test set	1661 reflections (5.48%)	wwPDB-VP
Wilson B-factor (Å²)	31.9	Xtriage
Anisotropy	0.230	Xtriage
Bulk solvent k_{sol}(e/Å³), B_{sol}(Å²)	0.35 , 28.7	EDS
L-test for twinning[2]	$< \lvert L \rvert > = 0.52, < L^2 > = 0.35$	Xtriage
Estimated twinning fraction	0.000 for -1/3*h+1/3*k+4/3*l,-k,2/3*h+1/3*k+1/3*l 0.000 for -2/3*h-1/3*k-4/3*l,-1/3*h-2/3*k+4/3*l,-1/3*h+1/3*k+1/3*l 0.000 for -h,1/3*h-1/3*k-4/3*l,-1/3*h-2/3*k+1/3*l 0.015 for -1/3*h-2/3*k+4/3*l,-2/3*h-1/3*k-4/3*l,1/3*h-1/3*k-1/3*l 0.000 for -h,2/3*h+1/3*k+4/3*l,1/3*h+2/3*k-1/3*l 0.000 for 1/3*h+2/3*k-4/3*l,-k,-2/3*h-1/3*k-1/3*l 0.025 for h,-h-k,-l	Xtriage
F_o,F_c correlation	0.98	EDS
Total number of atoms	2429	wwPDB-VP
Average B, all atoms (Å²)	41.0	wwPDB-VP

Xtriage's analysis on translational NCS is as follows: *The largest off-origin peak in the Patterson function is 6.10% of the height of the origin peak. No significant pseudotranslation is detected.*

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[1]Intensities estimated from amplitudes.
[2]Theoretical values of $< \lvert L \rvert >$, $< L^2 >$ 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: PG4, PGE, K, PEG, SPM

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	0.37	0/616	0.58	0/956
1	B	0.38	0/616	0.58	0/956
1	C	0.31	0/616	0.54	0/956
1	D	0.35	0/616	0.55	0/956
All	All	0.35	0/2464	0.56	0/3824

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	549	0	298	0	0
1	B	549	0	298	5	0
1	C	549	0	298	3	0
1	D	549	0	298	1	0
2	A	3	0	0	0	0
2	B	3	0	0	0	0
2	C	3	0	0	0	0
2	D	3	0	0	0	0
3	B	28	0	52	3	0

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Mol	Chain	Non-H	H(model)	H(added)	Clashes	Symm-Clashes
4	B	7	0	10	0	0
5	C	26	0	36	3	0
6	C	10	0	14	0	0
6	D	10	0	14	0	0
7	A	33	0	0	0	0
7	B	44	0	0	0	0
7	C	39	0	0	1	0
7	D	24	0	0	0	0
All	All	2429	0	1318	9	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 2.

The worst 5 of 9 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:12:DG:OP2	3:B:104:SPM:H61	1.90	0.72
1:C:6:DT:H1'	5:C:105:PG4:H11	1.79	0.64
1:B:16:DT:OP1	3:B:104:SPM:H62	2.00	0.61
1:B:24:DG:OP2	5:C:105:PG4:H21	2.07	0.54
1:B:13:DT:OP1	3:B:104:SPM:H111	2.08	0.53

There are no symmetry-related clashes.

5.3 Torsion angles ⓘ

5.3.1 Protein backbone ⓘ

There are no protein molecules in this entry.

5.3.2 Protein sidechains ⓘ

There are no protein molecules in this entry.

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 19 ligands modelled in this entry, 12 are monoatomic - leaving 7 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	$\#|Z| > 2$
3	SPM	B	104	-	13,13,13	0.33	0	12,12,12	0.85	0
5	PG4	C	105	-	12,12,12	0.27	0	11,11,11	0.28	0
6	PGE	C	106	-	9,9,9	0.34	0	8,8,8	0.52	0
3	SPM	B	105	-	13,13,13	0.36	0	12,12,12	0.97	0
4	PEG	B	106	-	6,6,6	0.26	0	5,5,5	0.30	0
5	PG4	C	104	-	12,12,12	0.30	0	11,11,11	0.32	0
6	PGE	D	104	-	9,9,9	0.31	0	8,8,8	0.54	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
3	SPM	B	104	-	-	3/11/11/11	-
5	PG4	C	105	-	-	2/10/10/10	-
6	PGE	C	106	-	-	1/7/7/7	-
3	SPM	B	105	-	-	5/11/11/11	-
4	PEG	B	106	-	-	2/4/4/4	-
5	PG4	C	104	-	-	4/10/10/10	-
6	PGE	D	104	-	-	3/7/7/7	-

There are no bond length outliers.

There are no bond angle outliers.

There are no chirality outliers.

5 of 20 torsion outliers are listed below:

Mol	Chain	Res	Type	Atoms
6	C	106	PGE	O2-C3-C4-O3
3	B	105	SPM	N5-C6-C7-C8
3	B	104	SPM	C2-C3-C4-N5
3	B	105	SPM	N10-C11-C12-C13
6	D	104	PGE	O3-C5-C6-O4

There are no ring outliers.

3 monomers are involved in 6 short contacts:

Mol	Chain	Res	Type	Clashes	Symm-Clashes
3	B	104	SPM	3	0
5	C	105	PG4	2	0
5	C	104	PG4	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 ⓘ

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, 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(Å²)	Q<0.9
1	A	26/26 (100%)	-0.66	0	100	100	31, 39, 47, 53	0
1	B	26/26 (100%)	-0.68	0	100	100	30, 36, 44, 49	0
1	C	26/26 (100%)	-0.62	0	100	100	33, 45, 54, 61	0
1	D	26/26 (100%)	-0.50	0	100	100	33, 45, 54, 60	0
All	All	104/104 (100%)	-0.61	0	100	100	30, 39, 53, 61	0

There are no RSRZ outliers to report.

6.2 Non-standard residues in protein, DNA, RNA chains ⓘ

There are no non-standard protein/DNA/RNA residues in this entry.

6.3 Carbohydrates ⓘ

There are no oligosaccharides in this entry.

6.4 Ligands ⓘ

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(Å²)	Q<0.9
5	PG4	C	105	13/13	0.79	0.15	48,52,58,59	0
4	PEG	B	106	7/7	0.83	0.12	54,56,60,61	0
6	PGE	D	104	10/10	0.87	0.11	53,58,63,64	0
6	PGE	C	106	10/10	0.88	0.13	38,45,50,56	0

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Mol	Type	Chain	Res	Atoms	RSCC	RSR	B-factors(Å^2)	Q<0.9
3	SPM	B	104	14/14	0.92	0.11	27,34,41,46	0
3	SPM	B	105	14/14	0.92	0.11	32,38,41,43	0
5	PG4	C	104	13/13	0.94	0.10	39,43,49,50	0
2	K	D	102	1/1	0.98	0.05	30,30,30,30	0
2	K	D	103	1/1	0.98	0.06	30,30,30,30	0
2	K	D	101	1/1	0.98	0.04	29,29,29,29	0
2	K	A	102	1/1	0.99	0.07	30,30,30,30	0
2	K	A	103	1/1	0.99	0.03	26,26,26,26	0
2	K	B	101	1/1	0.99	0.03	28,28,28,28	0
2	K	B	102	1/1	0.99	0.04	28,28,28,28	0
2	K	B	103	1/1	0.99	0.03	27,27,27,27	0
2	K	C	101	1/1	0.99	0.04	35,35,35,35	0
2	K	C	102	1/1	0.99	0.03	34,34,34,34	0
2	K	C	103	1/1	0.99	0.03	31,31,31,31	0
2	K	A	101	1/1	0.99	0.04	31,31,31,31	0

6.5   Other polymers (i)

There are no such residues in this entry.