



wwPDB X-ray Structure Validation Summary Report ⓘ

Mar 5, 2026 – 07:53 PM UTC

PDB ID : 5LSJ / pdb_00005lsj
Title : CRYSTAL STRUCTURE OF THE HUMAN KINETOCHORE MIS12-CENP-C delta-HEAD2 COMPLEX
Authors : Vetter, I.R.; Petrovic, A.; Keller, J.; Liu, Y.
Deposited on : 2016-09-02
Resolution : 3.25 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
Xtrriage (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

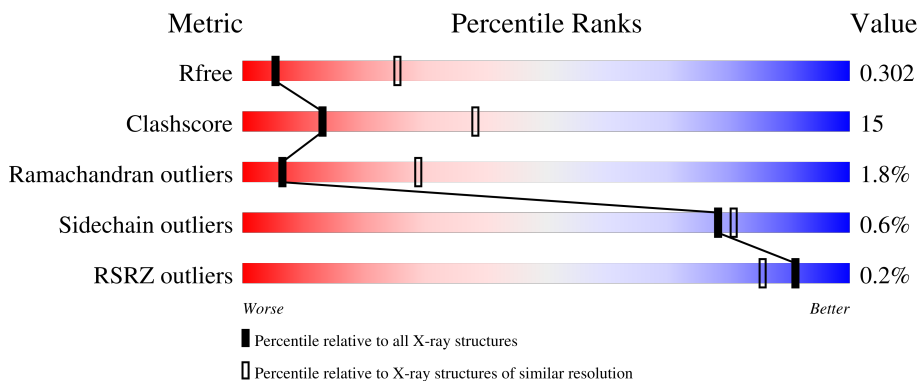
1 Overall quality at a glance

The following experimental techniques were used to determine the structure:

X-RAY DIFFRACTION

The reported resolution of this entry is 3.25 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.



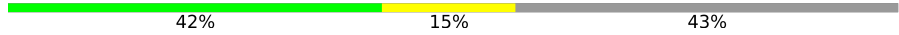




Metric	Whole archive (#Entries)	Similar resolution (#Entries, resolution range(Å))
R_{free}	180053	1605 (3.30-3.22)
Clashscore	190562	1660 (3.30-3.22)
Ramachandran outliers	187476	1630 (3.30-3.22)
Sidechain outliers	187428	1629 (3.30-3.22)
RSRZ outliers	180081	1605 (3.30-3.22)

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	205	 67% 30% .
1	C	205	 59% 37% ..
2	B	176	 61% 36% ..
2	E	176	 65% 32% ..
3	D	178	 38% 18% . 43%

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Mol	Chain	Length	Quality of chain
3	F	178	 42% 15% 43%
4	G	116	 55% 33% 12%
4	N	116	 % 52% 32% • 13%
5	P	76	 11% 7% 83%
5	Q	76	 9% 9% • 80%

2 Entry composition [i](#)

There are 5 unique types of molecules in this entry. The entry contains 9621 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 Protein MIS12 homolog.

Mol	Chain	Residues	Atoms					ZeroOcc	AltConf	Trace
			Total	C	N	O	S			
1	A	199	1642	1049	270	312	11	0	0	0
1	C	199	1642	1049	270	312	11	0	0	0

- Molecule 2 is a protein called Polyamine-modulated factor 1.

Mol	Chain	Residues	Atoms					ZeroOcc	AltConf	Trace
			Total	C	N	O	S			
2	B	173	1412	886	256	265	5	0	0	0
2	E	173	1412	886	256	265	5	0	0	0

There are 2 discrepancies between the modelled and reference sequences:

Chain	Residue	Modelled	Actual	Comment	Reference
B	30	MET	-	initiating methionine	UNP Q6P1K2
E	30	MET	-	initiating methionine	UNP Q6P1K2

- Molecule 3 is a protein called Kinetochores-associated protein DSN1 homolog.

Mol	Chain	Residues	Atoms					ZeroOcc	AltConf	Trace
			Total	C	N	O	S			
3	D	101	815	509	134	166	6	0	0	0
3	F	101	815	509	134	166	6	0	0	0

There are 14 discrepancies between the modelled and reference sequences:

Chain	Residue	Modelled	Actual	Comment	Reference
D	185	MET	-	initiating methionine	UNP Q9H410
D	357	HIS	-	expression tag	UNP Q9H410

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Chain	Residue	Modelled	Actual	Comment	Reference
D	358	HIS	-	expression tag	UNP Q9H410
D	359	HIS	-	expression tag	UNP Q9H410
D	360	HIS	-	expression tag	UNP Q9H410
D	361	HIS	-	expression tag	UNP Q9H410
D	362	HIS	-	expression tag	UNP Q9H410
F	185	MET	-	initiating methionine	UNP Q9H410
F	357	HIS	-	expression tag	UNP Q9H410
F	358	HIS	-	expression tag	UNP Q9H410
F	359	HIS	-	expression tag	UNP Q9H410
F	360	HIS	-	expression tag	UNP Q9H410
F	361	HIS	-	expression tag	UNP Q9H410
F	362	HIS	-	expression tag	UNP Q9H410

- Molecule 4 is a protein called Kinetochores-associated protein NSL1 homolog.

Mol	Chain	Residues	Atoms					ZeroOcc	AltConf	Trace
			Total	C	N	O	S			
4	N	101	810	516	135	154	5	0	0	0
4	G	102	821	525	136	155	5	0	0	0

There are 2 discrepancies between the modelled and reference sequences:

Chain	Residue	Modelled	Actual	Comment	Reference
N	91	MET	-	initiating methionine	UNP Q96IY1
G	91	MET	-	initiating methionine	UNP Q96IY1

- Molecule 5 is a protein called Centromere protein C.

Mol	Chain	Residues	Atoms					ZeroOcc	AltConf	Trace
			Total	C	N	O	S			
5	P	13	117	73	26	17	1	0	0	0
5	Q	15	135	84	31	19	1	0	0	0

There are 10 discrepancies between the modelled and reference sequences:

Chain	Residue	Modelled	Actual	Comment	Reference
P	-4	GLY	-	expression tag	UNP Q03188
P	-3	PRO	-	expression tag	UNP Q03188
P	-2	LEU	-	expression tag	UNP Q03188
P	-1	GLY	-	expression tag	UNP Q03188

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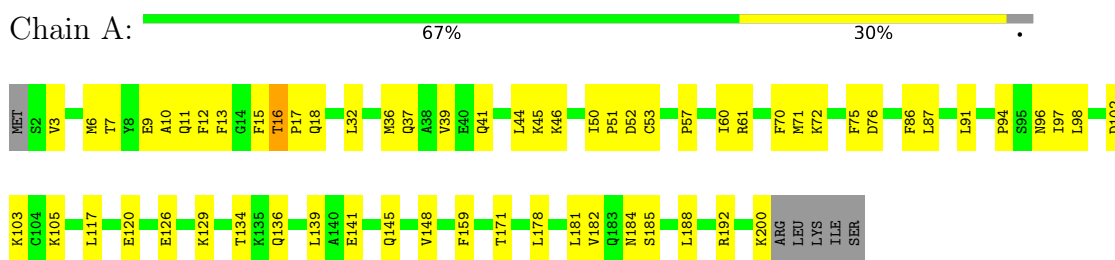
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Chain	Residue	Modelled	Actual	Comment	Reference
P	0	SER	-	expression tag	UNP Q03188
Q	-4	GLY	-	expression tag	UNP Q03188
Q	-3	PRO	-	expression tag	UNP Q03188
Q	-2	LEU	-	expression tag	UNP Q03188
Q	-1	GLY	-	expression tag	UNP Q03188
Q	0	SER	-	expression tag	UNP Q03188

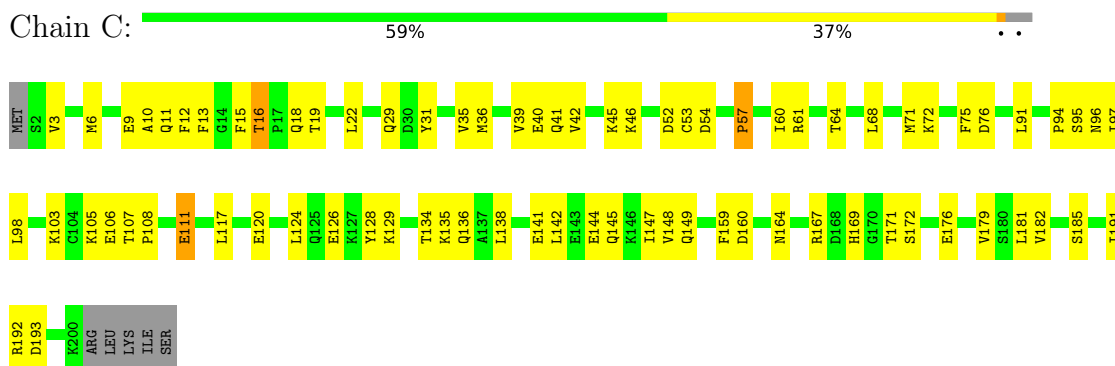
3 Residue-property plots [i](#)

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.

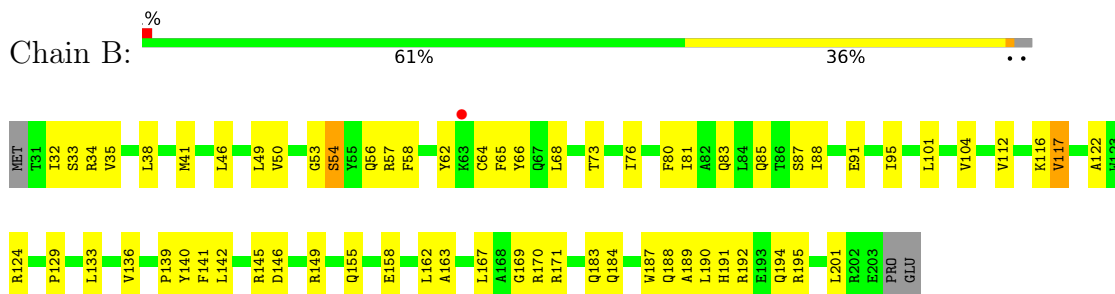
- Molecule 1: Protein MIS12 homolog



- Molecule 1: Protein MIS12 homolog



- Molecule 2: Polyamine-modulated factor 1

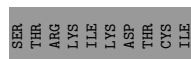
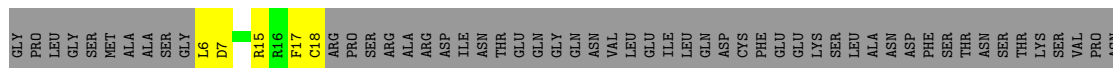


- Molecule 2: Polyamine-modulated factor 1

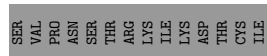
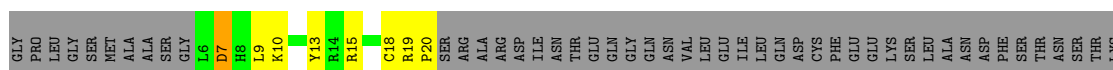




- Molecule 5: Centromere protein C



- Molecule 5: Centromere protein C



4 Data and refinement statistics

Property	Value	Source
Space group	P 1 21 1	Depositor
Cell constants a, b, c, α , β , γ	68.16Å 156.40Å 76.00Å 90.00° 102.82° 90.00°	Depositor
Resolution (Å)	19.99 – 3.25 19.99 – 3.25	Depositor EDS
% Data completeness (in resolution range)	99.7 (19.99-3.25) 99.2 (19.99-3.25)	Depositor EDS
R_{merge}	0.35	Depositor
R_{sym}	(Not available)	Depositor
$\langle I/\sigma(I) \rangle$ ¹	2.83 (at 2.81Å)	Xtrriage
Refinement program	PHENIX 1.10_2155	Depositor
R, R_{free}	0.246 , 0.297 0.251 , 0.302	Depositor DCC
R_{free} test set	1905 reflections (4.99%)	wwPDB-VP
Wilson B-factor (Å ²)	37.7	Xtrriage
Anisotropy	0.653	Xtrriage
Bulk solvent k_{sol} (e/Å ³), B_{sol} (Å ²)	0.26 , 22.4	EDS
L-test for twinning ²	$\langle L \rangle = 0.38$, $\langle L^2 \rangle = 0.21$	Xtrriage
Estimated twinning fraction	No twinning to report.	Xtrriage
F_o, F_c correlation	0.90	EDS
Total number of atoms	9621	wwPDB-VP
Average B, all atoms (Å ²)	54.0	wwPDB-VP

Xtrriage's analysis on translational NCS is as follows: *The largest off-origin peak in the Patterson function is 10.08% 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](#)

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	0.20	0/1671	0.45	0/2246
1	C	0.22	0/1671	0.47	0/2246
2	B	0.17	0/1433	0.46	0/1933
2	E	0.18	0/1433	0.48	0/1933
3	D	0.16	0/824	0.43	0/1104
3	F	0.15	0/824	0.38	0/1104
4	G	0.17	0/836	0.44	0/1126
4	N	0.30	1/824 (0.1%)	0.51	0/1110
5	P	0.18	0/119	0.51	0/156
5	Q	0.19	0/138	0.67	0/182
All	All	0.20	1/9773 (0.0%)	0.46	0/13140

All (1) bond length outliers are listed below:

Mol	Chain	Res	Type	Atoms	Z	Observed(Å)	Ideal(Å)
4	N	152	HIS	C-N	6.94	1.50	1.33

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	1642	0	1646	67	0
1	C	1642	0	1646	82	0

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Mol	Chain	Non-H	H(model)	H(added)	Clashes	Symm-Clashes
2	B	1412	0	1419	56	0
2	E	1412	0	1419	52	0
3	D	815	0	801	32	0
3	F	815	0	801	23	0
4	G	821	0	842	32	0
4	N	810	0	833	31	0
5	P	117	0	116	6	0
5	Q	135	0	136	7	0
All	All	9621	0	9659	288	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 15.

The worst 5 of 288 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:181:LEU:HD21	3:D:302:LEU:HD22	1.63	0.79
1:A:6:MET:HG3	1:A:18:GLN:HE22	1.47	0.79
2:B:46:LEU:HD21	2:B:88:ILE:HG21	1.68	0.74
2:E:46:LEU:HD21	2:E:88:ILE:HG21	1.71	0.72
1:A:7:THR:OG1	4:N:126:ARG:NH1	2.23	0.72

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
1	A	197/205 (96%)	187 (95%)	8 (4%)	2 (1%)	12 40
1	C	197/205 (96%)	181 (92%)	14 (7%)	2 (1%)	12 40
2	B	171/176 (97%)	161 (94%)	6 (4%)	4 (2%)	5 24

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Mol	Chain	Analysed	Favoured	Allowed	Outliers	Percentiles	
2	E	171/176 (97%)	164 (96%)	4 (2%)	3 (2%)	6	29
3	D	97/178 (54%)	96 (99%)	1 (1%)	0	100	100
3	F	97/178 (54%)	95 (98%)	2 (2%)	0	100	100
4	G	100/116 (86%)	90 (90%)	7 (7%)	3 (3%)	3	19
4	N	99/116 (85%)	86 (87%)	9 (9%)	4 (4%)	2	14
5	P	11/76 (14%)	8 (73%)	3 (27%)	0	100	100
5	Q	13/76 (17%)	8 (62%)	2 (15%)	3 (23%)	0	0
All	All	1153/1502 (77%)	1076 (93%)	56 (5%)	21 (2%)	6	29

5 of 21 Ramachandran outliers are listed below:

Mol	Chain	Res	Type
2	B	117	VAL
2	E	117	VAL
5	Q	7	ASP
4	N	166	PRO
4	G	155	VAL

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	
1	A	188/194 (97%)	187 (100%)	1 (0%)	81	82
1	C	188/194 (97%)	187 (100%)	1 (0%)	81	82
2	B	151/155 (97%)	150 (99%)	1 (1%)	76	79
2	E	151/155 (97%)	150 (99%)	1 (1%)	76	79
3	D	94/161 (58%)	93 (99%)	1 (1%)	65	75
3	F	94/161 (58%)	94 (100%)	0	100	100
4	G	93/104 (89%)	93 (100%)	0	100	100
4	N	92/104 (88%)	90 (98%)	2 (2%)	45	65
5	P	12/67 (18%)	12 (100%)	0	100	100

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Mol	Chain	Analysed	Rotameric	Outliers	Percentiles	
5	Q	14/67 (21%)	14 (100%)	0	100	100
All	All	1077/1362 (79%)	1070 (99%)	7 (1%)	78	81

5 of 7 residues with a non-rotameric sidechain are listed below:

Mol	Chain	Res	Type
4	N	160	LEU
4	N	173	LEU
2	E	68	LEU
1	C	111	GLU
3	D	268	LEU

Sometimes sidechains can be flipped to improve hydrogen bonding and reduce clashes. 5 of 10 such sidechains are listed below:

Mol	Chain	Res	Type
2	E	155	GLN
2	E	177	GLN
2	E	188	GLN
2	B	188	GLN
3	D	301	GLN

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	199/205 (97%)	-0.28	0 100 100	29, 48, 74, 143	0
1	C	199/205 (97%)	-0.22	0 100 100	30, 51, 81, 122	0
2	B	173/176 (98%)	-0.29	1 (0%) 85 73	30, 45, 65, 79	0
2	E	173/176 (98%)	-0.33	0 100 100	27, 47, 64, 73	0
3	D	101/178 (56%)	-0.18	0 100 100	33, 55, 77, 111	0
3	F	101/178 (56%)	-0.14	0 100 100	34, 60, 96, 129	0
4	G	102/116 (87%)	-0.09	0 100 100	30, 68, 104, 124	0
4	N	101/116 (87%)	-0.11	1 (0%) 79 62	29, 61, 93, 105	0
5	P	13/76 (17%)	0.02	0 100 100	52, 64, 74, 79	0
5	Q	15/76 (19%)	0.29	0 100 100	56, 69, 96, 101	0
All	All	1177/1502 (78%)	-0.22	2 (0%) 91 85	27, 52, 89, 143	0

All (2) RSRZ outliers are listed below:

Mol	Chain	Res	Type	RSRZ
4	N	152	HIS	2.3
2	B	63	LYS	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

There are no ligands in this entry.

6.5 Other polymers

There are no such residues in this entry.