



Full wwPDB X-ray Structure Validation Report ⓘ

Mar 10, 2026 – 05:52 AM UTC

PDB ID : 8DAP / pdb_00008dap
Title : [GA/TC] Self-Assembled 3D DNA Tensegrity Triangle with 24 bp Arm Length forming a Trigonal Hexagon
Authors : Lu, B.; Vecchioni, S.; Ohayon, Y.P.; Seeman, N.C.; Mao, C.; Sha, R.
Deposited on : 2022-06-13
Resolution : 6.47 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
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

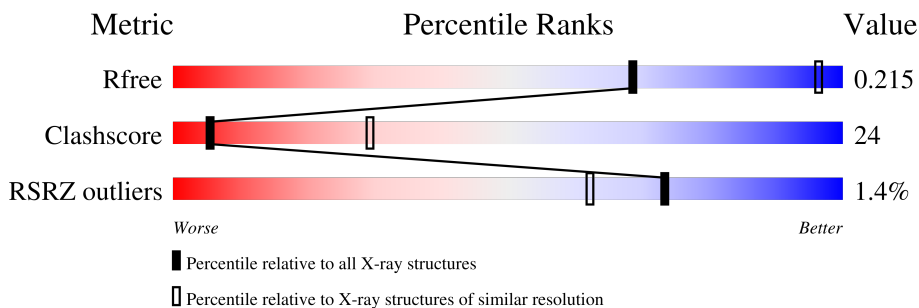
1 Overall quality at a glance

The following experimental techniques were used to determine the structure:

X-RAY DIFFRACTION

The reported resolution of this entry is 6.47 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	1157 (8.90-4.00)
Clashscore	190562	1019 (8.90-4.02)
RSRZ outliers	180081	1150 (8.90-4.00)

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	24	
1	E	24	
1	I	24	
2	C	17	
2	D	17	
2	H	17	
3	B	21	

2 Entry composition [i](#)

There are 3 unique types of molecules in this entry. The entry contains 2925 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*CP*TP*AP*CP*CP*CP*TP*GP*TP*AP*CP*GP*GP*AP*CP*AP*TP*CP*AP*G)-3').

Mol	Chain	Residues	Atoms					ZeroOcc	AltConf	Trace
1	E	24	Total	C	N	O	P	0	0	0
			487	232	92	140	23			
1	A	24	Total	C	N	O	P	0	0	0
			487	232	92	140	23			
1	I	24	Total	C	N	O	P	0	0	0
			487	232	92	140	23			

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

Mol	Chain	Residues	Atoms					ZeroOcc	AltConf	Trace
2	H	17	Total	C	N	O	P	0	0	0
			347	166	62	103	16			
2	C	17	Total	C	N	O	P	0	0	0
			347	166	62	103	16			
2	D	17	Total	C	N	O	P	0	0	0
			347	166	62	103	16			

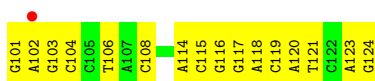
- Molecule 3 is a DNA chain called DNA (5'-D(P*TP*AP*CP*AP*CP*CP*GP*TP*AP*CP*AP*CP*CP*GP*TP*AP*CP*AP*CP*CP*G)-3').

Mol	Chain	Residues	Atoms					ZeroOcc	AltConf	Trace
3	B	21	Total	C	N	O	P	0	0	0
			423	201	78	123	21			

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*CP*TP*AP*CP*CP*CP*TP*GP*TP*AP*CP*GP*GP*AP*CP*AP*TP*CP*AP*G)-3')



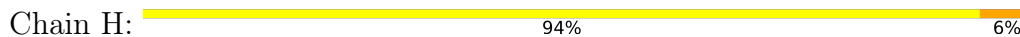
- Molecule 1: DNA (5'-D(*GP*AP*GP*CP*CP*TP*AP*CP*CP*CP*TP*GP*TP*AP*CP*GP*GP*AP*CP*AP*TP*CP*AP*G)-3')



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



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



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



T200
C201
C202
T203
G204
A205
T206
G207
T208
G209
G210
C211
T212
A213
G214
G215
C216

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

Chain D:  12% 76% 12%

T200
C201
C202
T203
G204
A205
T206
G207
T208
G209
G210
C211
T212
A213
G214
G215
C216

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

Chain B:  19% 76% 5%

T101
A102
C103
A104
C105
C106
G107
T108
A109
C110
A111
C112
A116
C117
A118
C119
C120
G121

4 Data and refinement statistics i

Property	Value	Source
Space group	P 32 2 1	Depositor
Cell constants a, b, c, α , β , γ	166.61Å 166.61Å 119.32Å 90.00° 90.00° 120.00°	Depositor
Resolution (Å)	55.13 – 6.47 55.13 – 6.47	Depositor EDS
% Data completeness (in resolution range)	90.1 (55.13-6.47) 83.4 (55.13-6.47)	Depositor EDS
R_{merge}	(Not available)	Depositor
R_{sym}	(Not available)	Depositor
$\langle I/\sigma(I) \rangle$ ¹	0.69 (at 6.71Å)	Xtrriage
Refinement program	PHENIX 1.20.1_4487	Depositor
R, R_{free}	0.140 , 0.173 (Not available) , 0.215	Depositor DCC
R_{free} test set	200 reflections (4.97%)	wwPDB-VP
Wilson B-factor (Å ²)	426.2	Xtrriage
Anisotropy	0.216	Xtrriage
Bulk solvent k_{sol} (e/Å ³), B_{sol} (Å ²)	0.14 , 731.0	EDS
L-test for twinning ²	$\langle L \rangle = 0.44$, $\langle L^2 \rangle = 0.27$	Xtrriage
Estimated twinning fraction	0.074 for -h,-k,l	Xtrriage
F_o, F_c correlation	0.99	EDS
Total number of atoms	2925	wwPDB-VP
Average B, all atoms (Å ²)	600.0	wwPDB-VP

Xtrriage's analysis on translational NCS is as follows: *The largest off-origin peak in the Patterson function is 7.81% 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	0.28	0/546	0.57	0/840
1	E	0.34	0/546	0.63	0/840
1	I	0.36	0/546	0.66	0/840
2	C	0.42	0/388	0.88	4/598 (0.7%)
2	D	0.39	0/388	1.36	4/598 (0.7%)
2	H	0.34	0/388	1.75	2/598 (0.3%)
3	B	0.23	0/473	1.54	4/725 (0.6%)
All	All	0.34	0/3275	1.10	14/5039 (0.3%)

There are no bond length outliers.

All (14) bond angle outliers are listed below:

Mol	Chain	Res	Type	Atoms	Z	Observed(°)	Ideal(°)
2	H	208	DT	O3'-P-O5'	-38.77	45.85	104.00
3	B	104	DA	O3'-P-O5'	-27.02	63.47	104.00
2	D	208	DT	P-O3'-C3'	25.20	158.00	120.20
3	B	118	DA	O3'-P-O5'	20.55	134.82	104.00
3	B	104	DA	P-O3'-C3'	15.74	143.81	120.20
3	B	118	DA	OP1-P-O3'	-9.45	79.64	108.00
2	D	208	DT	O3'-P-O5'	9.00	117.50	104.00
2	D	208	DT	OP1-P-O3'	-8.87	81.38	108.00
2	H	208	DT	OP2-P-O3'	7.30	129.92	108.00
2	C	200	DT	N1-C1'-C2'	7.28	124.42	113.50
2	C	200	DT	C3'-C2'-C1'	-6.95	91.17	101.60
2	C	200	DT	O4'-C1'-N1	6.70	118.45	108.40
2	D	201	DC	O5'-P-OP2	-6.40	88.80	108.00
2	C	200	DT	C1'-O4'-C4'	-5.69	101.16	109.70

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	487	0	270	20	0
1	E	487	0	270	17	0
1	I	487	0	270	17	0
2	C	347	0	194	19	1
2	D	347	0	194	20	1
2	H	347	0	194	19	0
3	B	423	0	235	15	0
All	All	2925	0	1627	106	1

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 24.

All (106) 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)
2:D:201:DC:H2'	2:D:202:DC:H4'	1.57	0.87
1:E:102:DA:H2''	1:E:103:DG:H5''	1.58	0.84
1:E:104:DC:H41	2:D:215:DG:H1	1.26	0.83
2:H:216:DC:H41	1:I:103:DG:H22	1.23	0.83
2:H:215:DG:H1	1:I:104:DC:H41	1.24	0.82
2:D:209:DG:H2'	2:D:210:DG:C8	2.24	0.71
3:B:106:DC:H2''	3:B:107:DG:N7	2.07	0.68
1:I:101:DG:H1'	1:I:102:DA:O5'	1.94	0.67
1:I:111:DT:H2'	1:I:112:DG:C8	2.30	0.67
1:A:104:DC:H2''	1:A:105:DC:O5'	1.95	0.66
1:E:104:DC:N4	2:D:215:DG:H22	1.95	0.63
1:E:119:DC:H2''	1:E:120:DA:N7	2.14	0.63
2:H:213:DA:H1'	2:H:214:DG:H8	1.64	0.62
2:H:216:DC:H41	1:I:103:DG:N2	1.96	0.62
1:A:105:DC:H2'	1:A:106:DT:H72	1.81	0.61
2:H:215:DG:H22	1:I:104:DC:N4	1.98	0.61
1:E:101:DG:H1'	1:E:102:DA:O4'	2.01	0.61
3:B:108:DT:H2''	3:B:109:DA:C8	2.37	0.60
2:C:202:DC:H1'	2:C:203:DT:OP2	2.02	0.60
1:I:102:DA:H2'	1:I:103:DG:C8	2.38	0.59

Continued on next page...

Continued from previous page...

Atom-1	Atom-2	Interatomic distance (Å)	Clash overlap (Å)
2:C:200:DT:H2''	2:C:201:DC:C5	2.38	0.59
2:H:202:DC:H1'	2:H:203:DT:OP2	2.03	0.58
3:B:118:DA:H2''	2:D:208:DT:H5'	1.86	0.58
2:D:203:DT:H4'	2:D:204:DG:OP1	2.04	0.57
2:H:209:DG:H2''	2:H:210:DG:C8	2.39	0.57
1:A:115:DC:H1'	1:A:116:DG:C5	2.39	0.57
1:I:109:DC:H2'	1:I:110:DC:C6	2.40	0.57
1:E:117:DG:H2''	1:E:118:DA:H8	1.69	0.56
1:A:123:DA:H2''	1:A:124:DG:N7	2.21	0.56
2:C:201:DC:H2''	2:C:202:DC:OP2	2.05	0.55
1:A:110:DC:H2'	1:A:111:DT:H71	1.88	0.55
2:C:207:DG:H2''	2:C:208:DT:H5''	1.89	0.55
2:H:204:DG:H1'	2:H:205:DA:H5'	1.89	0.54
1:E:116:DG:H2''	1:E:117:DG:C8	2.42	0.54
1:E:114:DA:H2''	1:E:115:DC:O5'	2.06	0.54
2:C:215:DG:H2''	2:C:216:DC:C4	2.43	0.53
3:B:102:DA:H2''	3:B:103:DC:C6	2.43	0.53
3:B:120:DC:H2''	3:B:121:DG:N7	2.23	0.53
2:D:212:DT:H2'	2:D:213:DA:C8	2.44	0.53
1:I:119:DC:H2''	1:I:120:DA:C8	2.45	0.52
1:E:106:DT:O2	2:D:214:DG:N2	2.43	0.52
2:H:211:DC:H4'	2:H:212:DT:OP1	2.10	0.51
3:B:109:DA:H2''	3:B:110:DC:C5	2.45	0.51
1:A:117:DG:H2''	1:A:118:DA:H8	1.76	0.51
1:A:114:DA:H2''	1:A:115:DC:C6	2.46	0.50
3:B:110:DC:H2''	3:B:111:DA:OP2	2.11	0.50
2:H:208:DT:H2'	3:B:112:DC:O4'	2.12	0.50
1:A:120:DA:N1	2:D:205:DA:N6	2.60	0.49
1:E:120:DA:H1'	1:E:121:DT:C6	2.47	0.49
1:A:105:DC:H2'	1:A:106:DT:C7	2.43	0.49
2:H:210:DG:H1'	2:H:211:DC:OP2	2.12	0.49
2:C:203:DT:H2''	2:C:204:DG:O5'	2.11	0.49
1:E:114:DA:OP1	1:E:114:DA:H8	1.95	0.49
1:A:114:DA:H2''	1:A:115:DC:H6	1.78	0.48
2:H:215:DG:H1	1:I:104:DC:N4	2.03	0.48
1:I:117:DG:H2''	1:I:118:DA:H8	1.79	0.48
2:H:206:DT:H1'	2:H:207:DG:C8	2.49	0.48
2:C:206:DT:H2''	2:C:207:DG:C8	2.49	0.48
1:A:114:DA:OP1	1:A:114:DA:H8	1.96	0.48
1:A:119:DC:N4	2:D:206:DT:O4	2.47	0.48
2:C:213:DA:H1'	2:C:214:DG:C8	2.47	0.48

Continued on next page...

Continued from previous page...

Atom-1	Atom-2	Interatomic distance (Å)	Clash overlap (Å)
2:H:202:DC:H2''	2:H:203:DT:OP1	2.13	0.48
2:H:208:DT:H3'	3:B:111:DA:H2''	1.96	0.48
1:E:108:DC:H42	2:D:211:DC:N4	2.12	0.47
2:H:200:DT:H2''	2:H:201:DC:C5	2.50	0.47
2:C:203:DT:H2'	2:C:204:DG:H8	1.78	0.47
2:D:211:DC:H4'	2:D:212:DT:OP1	2.15	0.47
2:H:213:DA:H2''	2:H:214:DG:H5''	1.95	0.46
2:C:202:DC:H2''	2:C:203:DT:H72	1.97	0.46
2:D:210:DG:H2''	2:D:211:DC:OP1	2.14	0.46
3:B:105:DC:H5''	3:B:106:DC:C5	2.50	0.46
1:E:102:DA:H2''	1:E:103:DG:C5'	2.39	0.46
1:A:107:DA:H5'	1:A:107:DA:C8	2.51	0.46
2:C:212:DT:H2'	2:C:213:DA:C8	2.50	0.46
1:A:113:DT:H2''	1:A:114:DA:C8	2.50	0.45
1:A:116:DG:H2''	1:A:117:DG:C8	2.51	0.45
2:C:211:DC:H2''	2:C:212:DT:O5'	2.16	0.45
1:I:107:DA:H8	1:I:107:DA:H5''	1.82	0.45
1:I:116:DG:H2''	1:I:117:DG:N7	2.32	0.45
1:I:122:DC:C2	1:I:123:DA:N7	2.84	0.45
2:H:207:DG:C5	2:H:208:DT:C4	3.05	0.45
2:C:203:DT:C2	2:C:204:DG:C8	3.05	0.45
1:I:101:DG:H4'	1:I:102:DA:OP1	2.16	0.44
2:D:202:DC:H2'	2:D:203:DT:C6	2.52	0.44
2:D:203:DT:H2''	2:D:204:DG:H8	1.82	0.44
1:E:123:DA:C2	1:E:124:DG:C5	3.05	0.44
1:A:110:DC:C2	2:C:210:DG:N2	2.85	0.44
3:B:101:DT:H1'	3:B:102:DA:H5'	1.99	0.44
3:B:116:DA:H2''	3:B:117:DC:C6	2.53	0.44
2:C:210:DG:N2	2:C:211:DC:N3	2.66	0.44
2:D:202:DC:H2'	2:D:203:DT:C5	2.52	0.44
1:A:117:DG:H4'	1:A:118:DA:OP1	2.17	0.43
3:B:105:DC:C4	2:C:208:DT:C4	3.06	0.43
1:E:117:DG:H2''	1:E:118:DA:C8	2.50	0.43
1:I:113:DT:H1'	1:I:114:DA:OP2	2.19	0.43
2:C:212:DT:H2'	2:C:213:DA:C5	2.54	0.43
1:I:112:DG:H2'	1:I:113:DT:C5	2.53	0.43
2:D:209:DG:H2'	2:D:210:DG:H8	1.81	0.42
1:A:104:DC:N4	2:C:215:DG:H2''	2.34	0.42
1:A:104:DC:H41	2:C:215:DG:H2''	1.85	0.42
3:B:118:DA:OP2	2:D:208:DT:H73	2.20	0.42
1:E:104:DC:H42	2:D:215:DG:H22	1.66	0.41

Continued on next page...

Continued from previous page...

Atom-1	Atom-2	Interatomic distance (Å)	Clash overlap (Å)
3:B:102:DA:H2''	3:B:103:DC:C5	2.56	0.41
1:A:108:DC:H2''	1:A:109:DC:C6	2.56	0.41
1:E:123:DA:C2	2:H:204:DG:C2	3.10	0.40
2:D:201:DC:OP2	2:D:201:DC:H6	2.04	0.40

All (1) 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)
2:C:200:DT:O5'	2:D:216:DC:O2[3_654]	2.07	0.13

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	24/24 (100%)	-0.57	0 100 100	432, 540, 714, 786	0
1	E	24/24 (100%)	0.05	1 (4%) 40 40	546, 634, 895, 1248	0
1	I	24/24 (100%)	-0.12	1 (4%) 40 40	494, 599, 705, 875	0
2	C	17/17 (100%)	-0.23	0 100 100	482, 635, 890, 893	0
2	D	17/17 (100%)	-0.41	0 100 100	502, 553, 776, 999	0
2	H	17/17 (100%)	-0.58	0 100 100	432, 614, 713, 754	0
3	B	21/21 (100%)	-0.42	0 100 100	427, 482, 506, 545	0
All	All	144/144 (100%)	-0.31	2 (1%) 73 62	427, 579, 796, 1248	0

All (2) RSRZ outliers are listed below:

Mol	Chain	Res	Type	RSRZ
1	I	124	DG	3.6
1	E	102	DA	3.2

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.