



Full wwPDB X-ray Structure Validation Report ⓘ

Mar 8, 2026 – 07:53 AM UTC

PDB ID : 1XOC / pdb_00001xoc
Title : The structure of the oligopeptide-binding protein, AppA, from *Bacillus subtilis* in complex with a nonapeptide.
Authors : Levdikov, V.M.; Blagova, E.V.; Brannigan, J.A.; Wright, L.; Vagin, A.A.; Wilkinson, A.J.
Deposited on : 2004-10-06
Resolution : 1.55 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

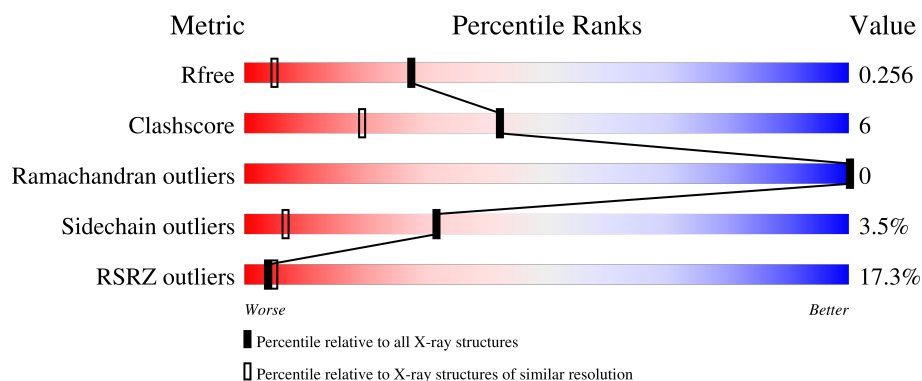
1 Overall quality at a glance

The following experimental techniques were used to determine the structure:

X-RAY DIFFRACTION

The reported resolution of this entry is 1.55 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	2145 (1.56-1.56)
Clashscore	190562	2189 (1.56-1.56)
Ramachandran outliers	187476	2153 (1.56-1.56)
Sidechain outliers	187428	2150 (1.56-1.56)
RSRZ outliers	180081	2146 (1.56-1.56)

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	520	16% 85% 10% ...
2	B	9	44% 56% 22% 22%

2 Entry composition

There are 4 unique types of molecules in this entry. The entry contains 4650 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 Oligopeptide-binding protein appA.

Mol	Chain	Residues	Atoms					ZeroOcc	AltConf	Trace
1	A	504	Total	C	N	O	S	0	9	0
			4118	2648	660	801	9			

There is a discrepancy between the modelled and reference sequences:

Chain	Residue	Modelled	Actual	Comment	Reference
A	1	SER	CYS	cloning artifact	UNP P42061

- Molecule 2 is a protein called Nonapeptide VDSKNTSSW.

Mol	Chain	Residues	Atoms				ZeroOcc	AltConf	Trace
2	B	9	Total	C	N	O	0	2	0
			76	46	13	17			

- Molecule 3 is ZINC ION (CCD ID: ZN) (formula: Zn).

Mol	Chain	Residues	Atoms		ZeroOcc	AltConf
3	A	15	Total	Zn	0	2
			15	15		

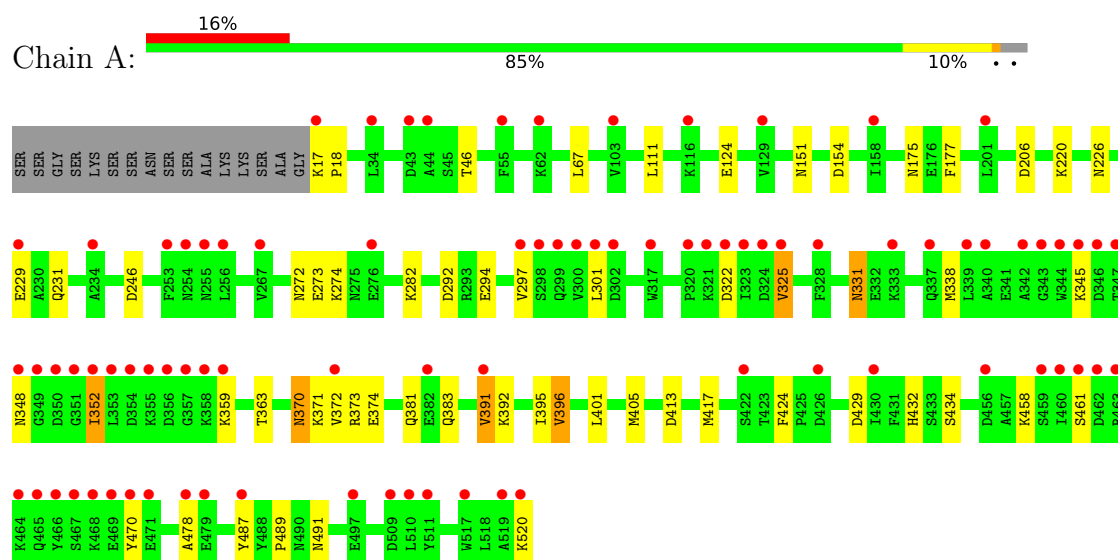
- Molecule 4 is water.

Mol	Chain	Residues	Atoms		ZeroOcc	AltConf
4	A	435	Total	O	0	6
			435	435		
4	B	6	Total	O	0	1
			6	6		

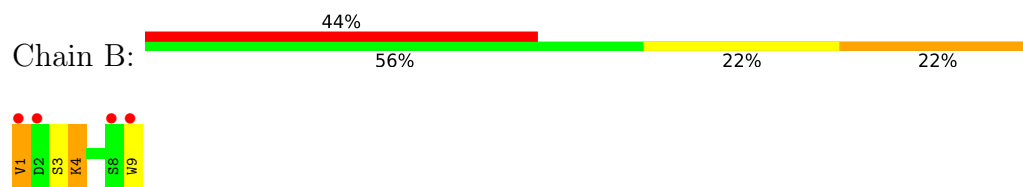
3 Residue-property plots [i](#)

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: Oligopeptide-binding protein appA



- Molecule 2: Nonapeptide VDSKNTSSW



4 Data and refinement statistics

Property	Value	Source
Space group	P 21 21 2	Depositor
Cell constants a, b, c, α , β , γ	120.95Å 90.78Å 54.72Å 90.00° 90.00° 90.00°	Depositor
Resolution (Å)	30.57 – 1.55 30.57 – 1.55	Depositor EDS
% Data completeness (in resolution range)	100.0 (30.57-1.55) 99.7 (30.57-1.55)	Depositor EDS
R_{merge}	0.08	Depositor
R_{sym}	(Not available)	Depositor
$\langle I/\sigma(I) \rangle$ ¹	1.33 (at 1.54Å)	Xtriage
Refinement program	REFMAC 5.2.0005	Depositor
R, R_{free}	0.176 , 0.206 0.235 , 0.256	Depositor DCC
R_{free} test set	4411 reflections (5.01%)	wwPDB-VP
Wilson B-factor (Å ²)	20.6	Xtriage
Anisotropy	0.300	Xtriage
Bulk solvent k_{sol} (e/Å ³), B_{sol} (Å ²)	0.37 , 41.6	EDS
L-test for twinning ²	$\langle L \rangle = 0.49$, $\langle L^2 \rangle = 0.32$	Xtriage
Estimated twinning fraction	No twinning to report.	Xtriage
F_o, F_c correlation	0.95	EDS
Total number of atoms	4650	wwPDB-VP
Average B, all atoms (Å ²)	32.0	wwPDB-VP

Xtriage's analysis on translational NCS is as follows: *The largest off-origin peak in the Patterson function is 5.74% 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

5.1 Standard geometry

Bond lengths and bond angles in the following residue types are not validated in this section: ZN

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	0.75	0/4256	0.80	0/5748
2	B	0.74	0/114	0.74	0/148
All	All	0.75	0/4370	0.80	0/5896

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	4118	0	4058	48	0
2	B	76	0	68	10	0
3	A	15	0	0	0	0
4	A	435	0	0	12	0
4	B	6	0	0	0	0
All	All	4650	0	4126	53	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 6.

All (53) 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:226:ASN:HD21	1:A:371[A]:LYS:HZ2	0.95	0.91
1:A:226:ASN:ND2	1:A:371[A]:LYS:HZ2	1.68	0.91
1:A:226:ASN:HD21	1:A:371[A]:LYS:NZ	1.72	0.88
1:A:226:ASN:ND2	1:A:371[A]:LYS:NZ	2.30	0.79
4:A:655:HOH:O	2:B:1:VAL:HG21	1.93	0.68
1:A:352:ILE:HD11	1:A:359:LYS:HB2	1.75	0.67
4:A:656[B]:HOH:O	2:B:4[B]:LYS:HD2	1.99	0.62
1:A:17:LYS:NZ	4:A:935:HOH:O	2.33	0.60
1:A:46:THR:HG21	2:B:4[A]:LYS:HE2	1.83	0.59
1:A:371[B]:LYS:NZ	1:A:374:GLU:CD	2.62	0.58
1:A:175:ASN:HD22	1:A:177:PHE:H	1.52	0.56
1:A:331:ASN:HD22	1:A:331:ASN:C	2.13	0.56
1:A:151:ASN:ND2	1:A:424:PHE:HB3	2.20	0.56
1:A:396:VAL:HG22	1:A:401:LEU:HB2	1.87	0.56
1:A:17:LYS:HB3	1:A:18:PRO:HD3	1.89	0.55
1:A:292:ASP:H	1:A:383:GLN:NE2	2.05	0.55
1:A:292:ASP:H	1:A:383:GLN:HE22	1.55	0.55
1:A:297:VAL:HA	1:A:301:LEU:HD23	1.88	0.55
1:A:370:ASN:HD22	1:A:370:ASN:C	2.15	0.54
1:A:429:ASP:CG	4:A:910:HOH:O	2.52	0.52
1:A:432:HIS:HD2	1:A:434:SER:H	1.58	0.52
1:A:405:MET:HE1	1:A:417:MET:HE3	1.93	0.51
1:A:458:LYS:NZ	4:A:538:HOH:O	2.30	0.51
4:A:798:HOH:O	2:B:1:VAL:HG11	2.09	0.51
1:A:272:ASN:C	1:A:272:ASN:HD22	2.18	0.50
1:A:371[B]:LYS:NZ	1:A:374:GLU:OE2	2.45	0.49
4:A:656[B]:HOH:O	2:B:4[B]:LYS:CD	2.59	0.49
1:A:363:THR:OG1	1:A:392:LYS:HE3	2.13	0.48
1:A:206:ASP:OD2	4:A:836:HOH:O	2.20	0.48
1:A:151:ASN:HD21	1:A:424:PHE:HB3	1.77	0.47
1:A:489:PRO:HB3	2:B:9[A]:TRP:HB3	1.96	0.47
1:A:371[B]:LYS:NZ	4:A:815:HOH:O	2.48	0.47
2:B:3:SER:C	2:B:4[A]:LYS:HD3	2.40	0.46
1:A:374:GLU:HG2	1:A:395[B]:ILE:HD12	1.97	0.46
1:A:322:ASP:OD2	1:A:322:ASP:N	2.49	0.46
1:A:282:LYS:NZ	1:A:338:MET:O	2.35	0.46
1:A:487:TYR:OH	2:B:9[C]:TRP:OXT	2.30	0.45
1:A:175:ASN:ND2	1:A:177:PHE:H	2.15	0.44
1:A:229:GLU:HB3	4:A:740:HOH:O	2.15	0.44
1:A:272:ASN:ND2	1:A:274:LYS:H	2.13	0.44
1:A:373:ARG:NE	2:B:9[B]:TRP:O	2.48	0.44
1:A:413:ASP:OD2	4:A:715:HOH:O	2.21	0.44

Continued on next page...

Continued from previous page...

Atom-1	Atom-2	Interatomic distance (Å)	Clash overlap (Å)
1:A:381:GLN:HA	1:A:391:VAL:HG13	1.99	0.44
1:A:272:ASN:HD22	1:A:273:GLU:N	2.17	0.42
1:A:370:ASN:ND2	1:A:373:ARG:H	2.17	0.42
1:A:432:HIS:CD2	1:A:434:SER:H	2.37	0.42
1:A:220:LYS:NZ	1:A:231:GLN:HE22	2.18	0.41
1:A:124:GLU:CG	4:A:959:HOH:O	2.68	0.41
1:A:370:ASN:HD21	1:A:372:VAL:HB	1.84	0.41
1:A:325:VAL:HG13	1:A:478:ALA:HB1	2.01	0.41
1:A:154:ASP:CG	2:B:1:VAL:HG13	2.46	0.40
1:A:246:ASP:OD1	1:A:371[A]:LYS:NZ	2.52	0.40

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	511/520 (98%)	501 (98%)	10 (2%)	0	100	100
2	B	8/9 (89%)	8 (100%)	0	0	100	100
All	All	519/529 (98%)	509 (98%)	10 (2%)	0	100	100

There are no Ramachandran outliers to report.

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	452/455 (99%)	437 (97%)	15 (3%)	33	7
2	B	12/9 (133%)	9 (75%)	3 (25%)	0	0
All	All	464/464 (100%)	446 (96%)	18 (4%)	32	5

All (18) residues with a non-rotameric sidechain are listed below:

Mol	Chain	Res	Type
1	A	67[A]	LEU
1	A	67[B]	LEU
1	A	111	LEU
1	A	294	GLU
1	A	325	VAL
1	A	331	ASN
1	A	345	LYS
1	A	348	ASN
1	A	352	ILE
1	A	370	ASN
1	A	391	VAL
1	A	396	VAL
1	A	461	SER
1	A	470	TYR
1	A	520	LYS
2	B	1	VAL
2	B	4[A]	LYS
2	B	4[B]	LYS

Sometimes sidechains can be flipped to improve hydrogen bonding and reduce clashes. All (13) such sidechains are listed below:

Mol	Chain	Res	Type
1	A	50	ASN
1	A	175	ASN
1	A	197	GLN
1	A	226	ASN
1	A	231	GLN
1	A	272	ASN
1	A	285	GLN
1	A	331	ASN
1	A	370	ASN
1	A	383	GLN
1	A	432	HIS
1	A	475	GLN

Continued on next page...

Continued from previous page...

Mol	Chain	Res	Type
1	A	481	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](#)

Of 15 ligands modelled in this entry, 15 are monoatomic - leaving 0 for Mogul analysis.

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

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(Å ²)	Q<0.9
1	A	504/520 (96%)	1.40	85 (16%) 4 5	18, 31, 37, 44	9 (1%)
2	B	9/9 (100%)	2.75	4 (44%) 0 0	17, 30, 33, 34	3 (33%)
All	All	513/529 (96%)	1.42	89 (17%) 4 5	17, 31, 37, 44	12 (2%)

All (89) RSRZ outliers are listed below:

Mol	Chain	Res	Type	RSRZ
2	B	9[A]	TRP	7.7
1	A	322	ASP	6.6
1	A	349	GLY	5.7
2	B	1	VAL	5.7
1	A	461	SER	5.3
1	A	229	GLU	5.3
1	A	323	ILE	5.2
1	A	352	ILE	5.2
1	A	348	ASN	4.9
1	A	324	ASP	4.6
1	A	358	LYS	4.3
1	A	426	ASP	4.3
1	A	321	LYS	4.2
1	A	342	ALA	4.1
1	A	340	ALA	4.0
1	A	346	ASP	4.0
1	A	351	GLY	4.0
1	A	357	GLY	3.9
1	A	333	LYS	3.9
1	A	344	TRP	3.9
1	A	462	ASP	3.9
1	A	343	GLY	3.8
1	A	347	THR	3.8
1	A	345	LYS	3.7

Continued on next page...

Continued from previous page...

Mol	Chain	Res	Type	RSRZ
1	A	465	GLN	3.7
1	A	320	PRO	3.6
1	A	116	LYS	3.6
1	A	350	ASP	3.6
1	A	298	SER	3.5
1	A	460	ILE	3.5
1	A	297	VAL	3.5
1	A	302	ASP	3.4
1	A	276	GLU	3.3
1	A	464	LYS	3.3
1	A	487	TYR	3.2
1	A	337	GLN	3.2
1	A	459	SER	3.2
1	A	356	ASP	3.1
1	A	325	VAL	3.1
1	A	520	LYS	3.1
2	B	8	SER	3.0
1	A	301	LEU	2.9
1	A	519	ALA	2.9
1	A	430	ILE	2.9
1	A	339	LEU	2.9
1	A	466	TYR	2.8
1	A	234	ALA	2.7
1	A	353	LEU	2.7
1	A	129	VAL	2.7
1	A	255	ASN	2.6
1	A	158	ILE	2.6
1	A	44	ALA	2.6
1	A	467	SER	2.6
1	A	267	VAL	2.6
1	A	456	ASP	2.6
1	A	300	VAL	2.5
1	A	55	PHE	2.5
1	A	463	ARG	2.5
1	A	478	ALA	2.5
1	A	254	ASN	2.5
1	A	391	VAL	2.5
1	A	43	ASP	2.4
1	A	468	LYS	2.4
1	A	355	LYS	2.3
1	A	354	ASP	2.3
1	A	359	LYS	2.3

Continued on next page...

Continued from previous page...

Mol	Chain	Res	Type	RSRZ
1	A	253	PHE	2.3
1	A	299	GLN	2.3
1	A	517	TRP	2.3
1	A	469	GLU	2.3
1	A	422[A]	SER	2.3
1	A	62	LYS	2.2
1	A	471	GLU	2.2
1	A	201	LEU	2.1
1	A	510	LEU	2.1
1	A	382	GLU	2.1
1	A	479	GLU	2.1
1	A	497	GLU	2.1
1	A	328	PHE	2.1
1	A	372	VAL	2.1
1	A	509	ASP	2.1
1	A	34	LEU	2.1
1	A	256	LEU	2.1
1	A	17	LYS	2.1
1	A	470	TYR	2.1
1	A	317	TRP	2.1
1	A	103	VAL	2.0
1	A	511	TYR	2.0
2	B	2	ASP	2.0

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](#)

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.

Continued on next page...

Continued from previous page...

Mol	Type	Chain	Res	Atoms	RSCC	RSR	B-factors($\text{\AA}^2$)	Q<0.9
3	ZN	A	531	1/1	0.60	0.25	45,45,45,45	0
3	ZN	A	535	1/1	0.74	0.17	100,100,100,100	0
3	ZN	A	526	1/1	0.81	0.15	48,48,48,48	1
3	ZN	A	533	1/1	0.85	0.12	88,88,88,88	0
3	ZN	A	534	1/1	0.86	0.10	93,93,93,93	0
3	ZN	A	528	1/1	0.86	0.12	35,35,35,35	0
3	ZN	A	532	1/1	0.90	0.09	82,82,82,82	0
3	ZN	A	524[C]	1/1	0.95	0.14	30,30,30,30	1
3	ZN	A	530	1/1	0.97	0.12	38,38,38,38	0
3	ZN	A	529	1/1	0.97	0.15	36,36,36,36	1
3	ZN	A	525	1/1	0.98	0.19	39,39,39,39	0
3	ZN	A	521	1/1	0.99	0.04	18,18,18,18	1
3	ZN	A	522[A]	1/1	0.99	0.07	19,19,19,19	1
3	ZN	A	523	1/1	0.99	0.07	20,20,20,20	0
3	ZN	A	527	1/1	0.99	0.10	30,30,30,30	0

6.5 Other polymers [i](#)

There are no such residues in this entry.