



Full wwPDB X-ray Structure Validation Report ⓘ

Mar 9, 2026 – 04:22 PM UTC

PDB ID : 5VVM / pdb_00005vvm
Title : Crystal structure of human CDH23 EC21-23
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Deposited on : 2017-05-19
Resolution : 3.54 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

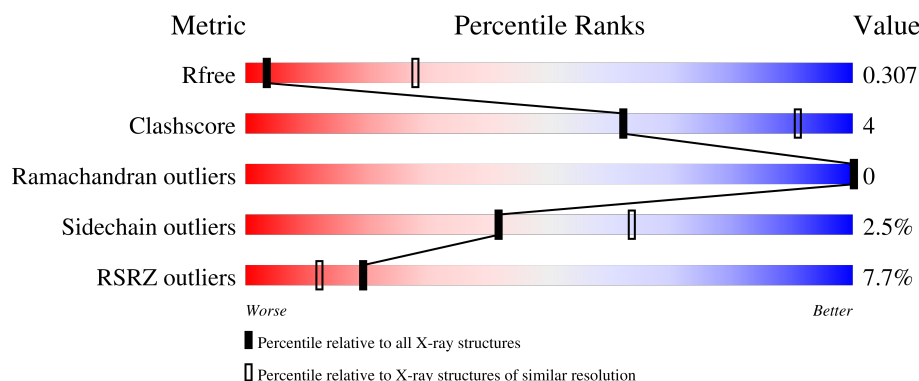
1 Overall quality at a glance

The following experimental techniques were used to determine the structure:

X-RAY DIFFRACTION

The reported resolution of this entry is 3.54 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	1008 (3.58-3.50)
Clashscore	190562	1062 (3.58-3.50)
Ramachandran outliers	187476	1033 (3.58-3.50)
Sidechain outliers	187428	1034 (3.58-3.50)
RSRZ outliers	180081	1007 (3.58-3.50)

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	346	7% 75% 11% 14%
1	B	346	7% 79% 12% 9%

2 Entry composition

There are 2 unique types of molecules in this entry. The entry contains 4670 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 Cadherin-23.

Mol	Chain	Residues	Atoms					ZeroOcc	AltConf	Trace
1	A	298	Total	C	N	O	S	0	0	0
			2257	1420	368	466	3			
1	B	314	Total	C	N	O	S	0	0	0
			2401	1510	394	494	3			

There are 18 discrepancies between the modelled and reference sequences:

Chain	Residue	Modelled	Actual	Comment	Reference
A	2145	MET	-	initiating methionine	UNP Q9H251
A	2483	LEU	-	expression tag	UNP Q9H251
A	2484	GLU	-	expression tag	UNP Q9H251
A	2485	HIS	-	expression tag	UNP Q9H251
A	2486	HIS	-	expression tag	UNP Q9H251
A	2487	HIS	-	expression tag	UNP Q9H251
A	2488	HIS	-	expression tag	UNP Q9H251
A	2489	HIS	-	expression tag	UNP Q9H251
A	2490	HIS	-	expression tag	UNP Q9H251
B	2145	MET	-	initiating methionine	UNP Q9H251
B	2483	LEU	-	expression tag	UNP Q9H251
B	2484	GLU	-	expression tag	UNP Q9H251
B	2485	HIS	-	expression tag	UNP Q9H251
B	2486	HIS	-	expression tag	UNP Q9H251
B	2487	HIS	-	expression tag	UNP Q9H251
B	2488	HIS	-	expression tag	UNP Q9H251
B	2489	HIS	-	expression tag	UNP Q9H251
B	2490	HIS	-	expression tag	UNP Q9H251

- Molecule 2 is CALCIUM ION (CCD ID: CA) (formula: Ca).

Mol	Chain	Residues	Atoms		ZeroOcc	AltConf
2	A	6	Total	Ca	0	0
			6	6		

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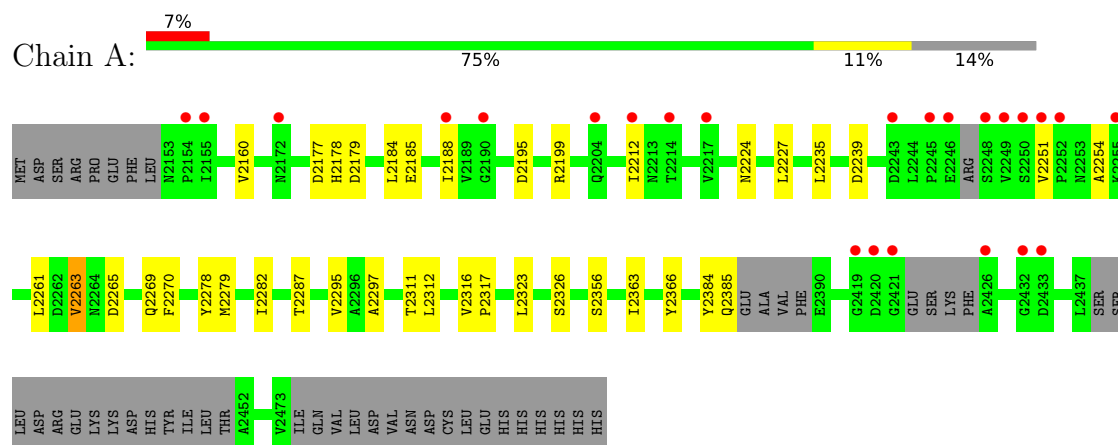
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Mol	Chain	Residues	Atoms		ZeroOcc	AltConf
2	B	6	Total 6	Ca 6	0	0

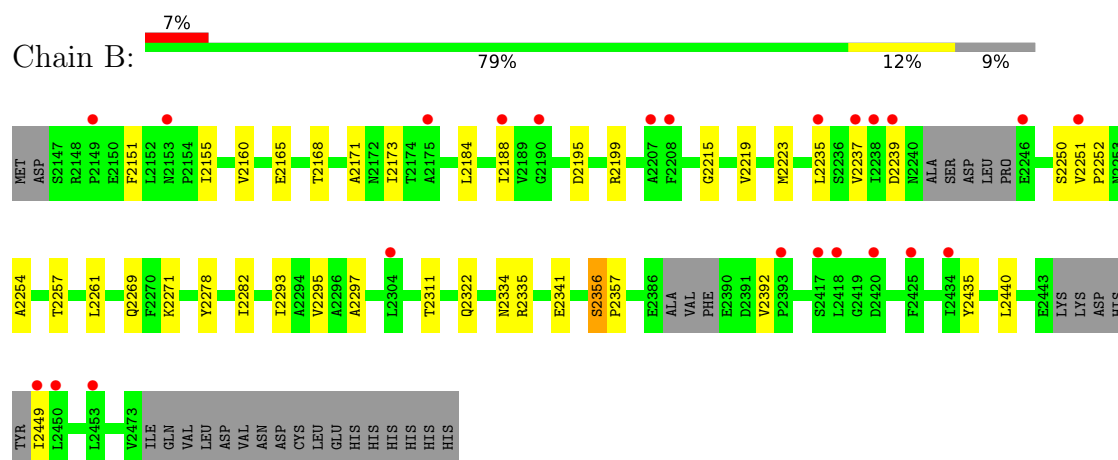
3 Residue-property plots [i](#)

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: Cadherin-23



• Molecule 1: Cadherin-23



4 Data and refinement statistics

Property	Value	Source
Space group	C 1 2 1	Depositor
Cell constants a, b, c, α , β , γ	116.71Å 166.81Å 47.93Å 90.00° 102.53° 90.00°	Depositor
Resolution (Å)	94.08 – 3.54 94.08 – 3.54	Depositor EDS
% Data completeness (in resolution range)	98.0 (94.08-3.54) 98.2 (94.08-3.54)	Depositor EDS
R_{merge}	0.16	Depositor
R_{sym}	(Not available)	Depositor
$\langle I/\sigma(I) \rangle$ ¹	2.21 (at 3.57Å)	Xtriage
Refinement program	REFMAC 5.8.0158	Depositor
R, R_{free}	0.303 , 0.346 (Not available) , 0.307	Depositor DCC
R_{free} test set	574 reflections (5.24%)	wwPDB-VP
Wilson B-factor (Å ²)	35.3	Xtriage
Anisotropy	0.141	Xtriage
Bulk solvent k_{sol} (e/Å ³), B_{sol} (Å ²)	0.26 , 38.2	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	0.81	EDS
Total number of atoms	4670	wwPDB-VP
Average B, all atoms (Å ²)	68.0	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 23.64 % 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 4.4829e-03. 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

5.1 Standard geometry

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

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	0/2295	0.87	1/3148 (0.0%)
1	B	0.73	0/2442	0.85	1/3344 (0.0%)
All	All	0.74	0/4737	0.86	2/6492 (0.0%)

Chiral center outliers are detected by calculating the chiral volume of a chiral center and verifying if the center is modelled as a planar moiety or with the opposite hand. A planarity outlier is detected by checking planarity of atoms in a peptide group, atoms in a mainchain group or atoms of a sidechain that are expected to be planar.

Mol	Chain	#Chirality outliers	#Planarity outliers
1	A	0	2
1	B	0	1
All	All	0	3

There are no bond length outliers.

All (2) bond angle outliers are listed below:

Mol	Chain	Res	Type	Atoms	Z	Observed($^{\circ}$)	Ideal($^{\circ}$)
1	B	2171	ALA	N-CA-C	5.59	116.46	108.74
1	A	2188	ILE	CB-CA-C	-5.41	104.38	111.25

There are no chirality outliers.

All (3) planarity outliers are listed below:

Mol	Chain	Res	Type	Group
1	A	2251	VAL	Peptide
1	A	2356	SER	Peptide
1	B	2356	SER	Peptide

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	2257	0	2208	19	1
1	B	2401	0	2353	20	1
2	A	6	0	0	0	0
2	B	6	0	0	0	0
All	All	4670	0	4561	38	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 4.

All (38) 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:2322:GLN:HB3	1:B:2334:ASN:HD21	1.70	0.57
1:B:2165:GLU:HG2	1:B:2168:THR:HG23	1.88	0.55
1:B:2356:SER:HB2	1:B:2357:PRO:CD	2.39	0.52
1:B:2392:VAL:HB	1:B:2440:LEU:HD22	1.92	0.52
1:B:2251:VAL:HB	1:B:2252:PRO:HD3	1.92	0.51
1:A:2184:LEU:HD23	1:A:2239:ASP:HA	1.93	0.51
1:B:2151:PHE:CE2	1:B:2254:ALA:HB2	2.47	0.50
1:A:2160:VAL:O	1:A:2261:LEU:N	2.42	0.50
1:B:2322:GLN:NE2	1:B:2334:ASN:OD1	2.36	0.50
1:B:2335:ARG:NH2	1:B:2341:GLU:OE2	2.45	0.50
1:A:2316:VAL:HG12	1:A:2317:PRO:HD3	1.93	0.49
1:B:2160:VAL:O	1:B:2261:LEU:N	2.42	0.49
1:B:2184:LEU:HD23	1:B:2239:ASP:HA	1.94	0.49
1:A:2287:THR:HG21	1:B:2257:THR:HG21	1.93	0.49
1:A:2224:ASN:ND2	1:A:2227:LEU:HG	2.27	0.49
1:A:2185:GLU:OE1	1:A:2212:ILE:HD11	2.15	0.47
1:B:2219:VAL:HG22	1:B:2223:MET:HE3	1.97	0.47
1:A:2312:LEU:HD12	1:A:2323:LEU:CD1	2.45	0.46
1:B:2237:VAL:HG12	1:B:2250:SER:HB3	1.99	0.44
1:A:2278:TYR:CE2	1:A:2295:VAL:HG12	2.53	0.44
1:B:2356:SER:HB2	1:B:2357:PRO:HD3	1.99	0.43
1:A:2312:LEU:HD12	1:A:2323:LEU:HD13	2.00	0.43
1:B:2235:LEU:HB2	1:B:2254:ALA:HB3	2.01	0.43

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Atom-1	Atom-2	Interatomic distance (Å)	Clash overlap (Å)
1:A:2385:GLN:OE1	1:A:2385:GLN:N	2.42	0.43
1:A:2195:ASP:OD2	1:A:2199:ARG:HB2	2.19	0.43
1:B:2278:TYR:CE2	1:B:2295:VAL:HG12	2.53	0.43
1:A:2263:VAL:HG12	1:A:2265:ASP:HB3	2.01	0.42
1:A:2224:ASN:HD22	1:A:2227:LEU:HG	1.84	0.42
1:A:2270:PHE:CE2	1:A:2363:ILE:HG12	2.55	0.42
1:B:2269:GLN:O	1:B:2297:ALA:HB1	2.19	0.42
1:A:2235:LEU:HB2	1:A:2254:ALA:HB3	2.02	0.42
1:B:2195:ASP:OD2	1:B:2199:ARG:HB2	2.20	0.42
1:A:2279:MET:HA	1:A:2366:TYR:O	2.20	0.42
1:A:2270:PHE:CD2	1:A:2363:ILE:HG12	2.55	0.41
1:A:2269:GLN:O	1:A:2297:ALA:HB1	2.21	0.40
1:B:2151:PHE:CE1	1:B:2237:VAL:HG12	2.56	0.40
1:B:2173:ILE:HG13	1:B:2215:GLY:O	2.21	0.40
1:A:2177:ASP:C	1:A:2179:ASP:H	2.29	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)
1:A:2326:SER:OG	1:B:2356:SER:O[2_455]	2.15	0.05

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	288/346 (83%)	262 (91%)	26 (9%)	0	100	100
1	B	306/346 (88%)	280 (92%)	26 (8%)	0	100	100
All	All	594/692 (86%)	542 (91%)	52 (9%)	0	100	100

There are no Ramachandran outliers to report.

5.3.2 Protein sidechains

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	256/303 (84%)	251 (98%)	5 (2%)	48	67
1	B	273/303 (90%)	265 (97%)	8 (3%)	37	60
All	All	529/606 (87%)	516 (98%)	13 (2%)	42	63

All (13) residues with a non-rotameric sidechain are listed below:

Mol	Chain	Res	Type
1	A	2178	HIS
1	A	2263	VAL
1	A	2282	ILE
1	A	2311	THR
1	A	2384	TYR
1	B	2155	ILE
1	B	2188	ILE
1	B	2271	LYS
1	B	2282	ILE
1	B	2293	ILE
1	B	2311	THR
1	B	2435	TYR
1	B	2449	ILE

Sometimes sidechains can be flipped to improve hydrogen bonding and reduce clashes. All (5) such sidechains are listed below:

Mol	Chain	Res	Type
1	A	2172	ASN
1	A	2410	ASN
1	B	2172	ASN
1	B	2211	ASN
1	B	2381	GLN

5.3.3 RNA

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 12 ligands modelled in this entry, 12 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	298/346 (86%)	0.80	24 (8%) 18 11	39, 63, 105, 130	0
1	B	314/346 (90%)	0.85	23 (7%) 21 13	37, 63, 124, 153	0
All	All	612/692 (88%)	0.83	47 (7%) 19 12	37, 63, 113, 153	0

All (47) RSRZ outliers are listed below:

Mol	Chain	Res	Type	RSRZ
1	B	2417	SER	3.8
1	A	2421	GLY	3.6
1	A	2419	GLY	3.5
1	B	2418	LEU	3.3
1	A	2246	GLU	3.3
1	A	2251	VAL	3.2
1	B	2246	GLU	3.1
1	A	2245	PRO	3.1
1	B	2420	ASP	3.0
1	A	2250	SER	2.8
1	A	2249	VAL	2.7
1	A	2248	SER	2.7
1	A	2204	GLN	2.7
1	B	2153	ASN	2.7
1	A	2426	ALA	2.5
1	A	2212	ILE	2.5
1	A	2217	VAL	2.5
1	B	2149	PRO	2.5
1	B	2450	LEU	2.4
1	B	2238	ILE	2.4
1	A	2243	ASP	2.4
1	A	2420	ASP	2.4
1	A	2255	LYS	2.4
1	B	2208	PHE	2.4

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Mol	Chain	Res	Type	RSRZ
1	B	2251	VAL	2.4
1	B	2207	ALA	2.4
1	B	2237	VAL	2.4
1	B	2393	PRO	2.3
1	A	2188	ILE	2.3
1	A	2252	PRO	2.3
1	B	2190	GLY	2.3
1	B	2449	ILE	2.3
1	A	2190	GLY	2.2
1	B	2425	PHE	2.2
1	B	2304	LEU	2.2
1	A	2155	ILE	2.2
1	B	2235	LEU	2.1
1	A	2214	THR	2.1
1	A	2433	ASP	2.1
1	A	2154	PRO	2.1
1	B	2239	ASP	2.1
1	B	2188	ILE	2.1
1	A	2172	ASN	2.1
1	A	2432	GLY	2.0
1	B	2434	ILE	2.0
1	B	2175	ALA	2.0
1	B	2453	LEU	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.

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Mol	Type	Chain	Res	Atoms	RSCC	RSR	B-factors($\text{\AA}^2$)	Q<0.9
2	CA	B	2501	1/1	0.84	0.12	43,43,43,43	0
2	CA	A	2501	1/1	0.93	0.07	44,44,44,44	0
2	CA	A	2504	1/1	0.95	0.06	59,59,59,59	0
2	CA	B	2504	1/1	0.96	0.03	56,56,56,56	0
2	CA	A	2502	1/1	0.97	0.06	42,42,42,42	0
2	CA	B	2502	1/1	0.98	0.06	41,41,41,41	0
2	CA	B	2503	1/1	0.99	0.03	39,39,39,39	0
2	CA	A	2505	1/1	0.99	0.03	55,55,55,55	0
2	CA	B	2505	1/1	0.99	0.02	55,55,55,55	0
2	CA	B	2506	1/1	0.99	0.05	63,63,63,63	0
2	CA	A	2503	1/1	1.00	0.07	42,42,42,42	0
2	CA	A	2506	1/1	1.00	0.02	61,61,61,61	0

6.5 Other polymers [i](#)

There are no such residues in this entry.