



Full wwPDB X-ray Structure Validation Report ⓘ

Mar 10, 2026 – 12:11 AM UTC

PDB ID : 5ZHB / pdb_00005zhb
Title : Structure of Cellobiose 2-Epimerase from Bacillus thermoamylovorans B4167
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Deposited on : 2018-03-12
Resolution : 1.85 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

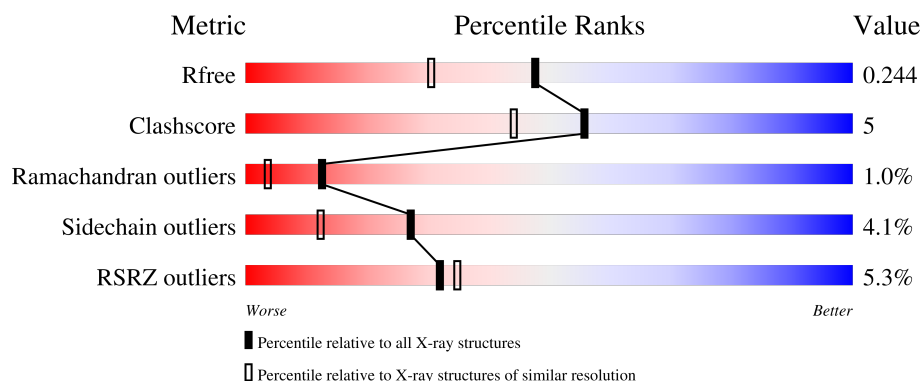
1 Overall quality at a glance

The following experimental techniques were used to determine the structure:

X-RAY DIFFRACTION

The reported resolution of this entry is 1.85 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	3428 (1.86-1.86)
Clashscore	190562	3579 (1.86-1.86)
Ramachandran outliers	187476	3553 (1.86-1.86)
Sidechain outliers	187428	3553 (1.86-1.86)
RSRZ outliers	180081	3429 (1.86-1.86)

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	390	5% 87% 10% ...
1	B	390	6% 86% 11% ..

2 Entry composition

There are 2 unique types of molecules in this entry. The entry contains 6833 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 Cellobiose 2-epimerase.

Mol	Chain	Residues	Atoms					ZeroOcc	AltConf	Trace
1	A	388	Total	C	N	O	S	0	6	0
			3317	2132	552	622	11			
1	B	389	Total	C	N	O	S	0	5	0
			3303	2123	546	623	11			

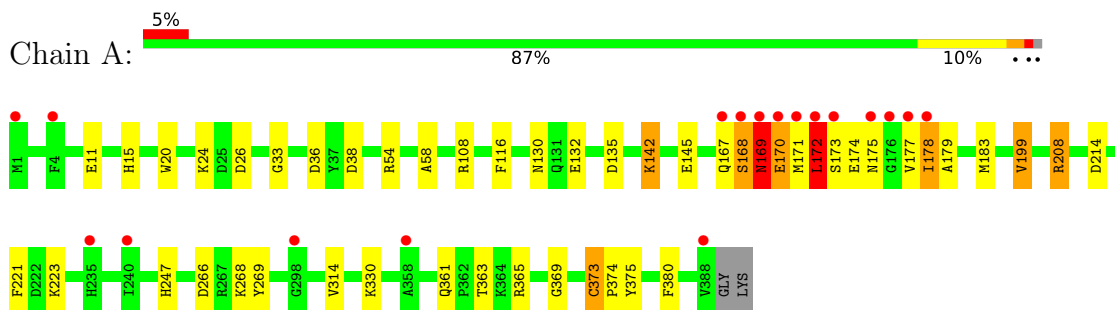
- Molecule 2 is water.

Mol	Chain	Residues	Atoms		ZeroOcc	AltConf
2	A	110	Total	O	0	0
			110	110		
2	B	103	Total	O	0	0
			103	103		

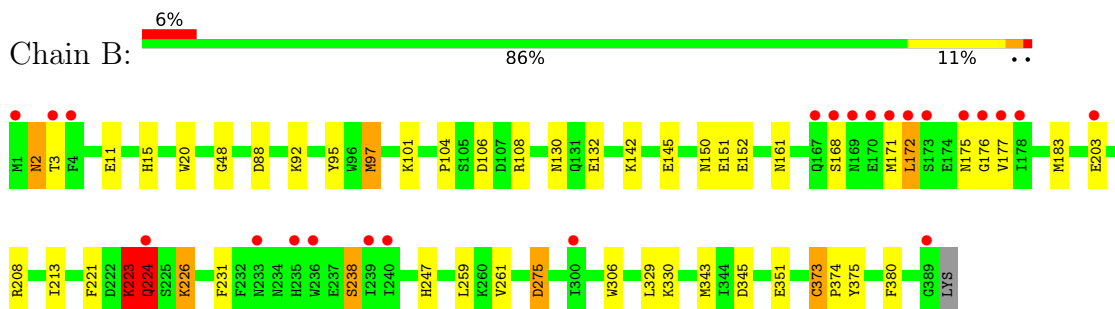
3 Residue-property plots

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: Cellobiose 2-epimerase



• Molecule 1: Cellobiose 2-epimerase



4 Data and refinement statistics

Property	Value	Source
Space group	C 1 2 1	Depositor
Cell constants a, b, c, α , β , γ	176.98Å 52.34Å 129.60Å 90.00° 129.94° 90.00°	Depositor
Resolution (Å)	39.63 – 1.85 39.63 – 1.85	Depositor EDS
% Data completeness (in resolution range)	98.1 (39.63-1.85) 98.1 (39.63-1.85)	Depositor EDS
R_{merge}	0.04	Depositor
R_{sym}	(Not available)	Depositor
$\langle I/\sigma(I) \rangle$ ¹	2.23 (at 1.85Å)	Xtriage
Refinement program	REFMAC 5.8.0419	Depositor
R, R_{free}	0.196 , 0.238 0.202 , 0.244	Depositor DCC
R_{free} test set	3916 reflections (5.01%)	wwPDB-VP
Wilson B-factor (Å ²)	27.7	Xtriage
Anisotropy	0.669	Xtriage
Bulk solvent k_{sol} (e/Å ³), B_{sol} (Å ²)	0.35 , 29.7	EDS
L-test for twinning ²	$\langle L \rangle = 0.50$, $\langle L^2 \rangle = 0.33$	Xtriage
Estimated twinning fraction	No twinning to report.	Xtriage
F_o, F_c correlation	0.96	EDS
Total number of atoms	6833	wwPDB-VP
Average B, all atoms (Å ²)	34.0	wwPDB-VP

Xtriage's analysis on translational NCS is as follows: *The largest off-origin peak in the Patterson function is 5.15% 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

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	0.58	0/3407	1.04	6/4610 (0.1%)
1	B	0.57	0/3396	1.06	6/4596 (0.1%)
All	All	0.57	0/6803	1.05	12/9206 (0.1%)

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	1
1	B	0	1
All	All	0	2

There are no bond length outliers.

All (12) bond angle outliers are listed below:

Mol	Chain	Res	Type	Atoms	Z	Observed(°)	Ideal(°)
1	A	199	VAL	N-CA-CB	-11.17	99.92	112.21
1	B	221	PHE	CA-CB-CG	7.86	121.66	113.80
1	A	169	ASN	CA-CB-CG	6.98	119.58	112.60
1	A	169	ASN	CB-CA-C	6.57	122.72	111.68
1	B	275	ASP	CA-CB-CG	5.63	118.23	112.60
1	A	221	PHE	CA-CB-CG	5.38	119.19	113.80
1	A	116	PHE	CA-CB-CG	-5.33	108.47	113.80
1	B	351	GLU	CB-CA-C	5.23	120.84	110.42
1	B	373	CYS	CB-CA-C	5.20	120.42	110.17
1	B	345	ASP	CA-CB-CG	5.04	117.64	112.60
1	A	373	CYS	CB-CA-C	5.01	120.05	110.17
1	B	223	LYS	N-CA-C	-5.01	103.54	110.35

There are no chirality outliers.

All (2) planarity outliers are listed below:

Mol	Chain	Res	Type	Group
1	A	208	ARG	Sidechain
1	B	172	LEU	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	3317	0	3140	34	0
1	B	3303	0	3117	27	0
2	A	110	0	0	4	0
2	B	103	0	0	2	1
All	All	6833	0	6257	61	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 5.

All (61) 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:108[B]:ARG:HH21	1:A:108[B]:ARG:HB3	1.36	0.91
1:A:36[A]:ASP:OD1	1:A:38[A]:ASP:OD1	1.91	0.89
1:A:135:ASP:HB2	2:A:490:HOH:O	1.74	0.86
1:A:108[B]:ARG:HB3	1:A:108[B]:ARG:NH2	1.99	0.78
1:A:108[B]:ARG:HH21	1:A:108[B]:ARG:CB	1.97	0.77
1:A:173:SER:O	1:A:175:ASN:N	2.23	0.70
1:B:20:TRP:CH2	1:B:373:CYS:HA	2.28	0.69
1:B:48:GLY:HA2	1:B:97:MET:HE2	1.75	0.69
1:B:2:ASN:HD22	1:B:2:ASN:N	1.94	0.66
1:B:145:GLU:OE1	1:B:208:ARG:CD	2.45	0.65
1:B:145:GLU:OE1	1:B:208:ARG:HD3	1.96	0.64
1:B:373:CYS:HB2	1:B:374:PRO:CD	2.27	0.63
1:B:11:GLU:OE2	1:B:15:HIS:HD2	1.81	0.63
1:A:145:GLU:OE1	1:A:208:ARG:HD3	2.00	0.62
1:A:20:TRP:CH2	1:A:373:CYS:HA	2.35	0.62
1:B:101:LYS:HE3	2:B:498:HOH:O	2.00	0.60

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Atom-1	Atom-2	Interatomic distance (Å)	Clash overlap (Å)
1:A:373:CYS:HB2	1:A:374:PRO:CD	2.32	0.60
1:A:167[B]:GLN:O	1:A:168:SER:C	2.46	0.58
1:B:373:CYS:HB2	1:B:374:PRO:HD3	1.85	0.58
1:A:11:GLU:OE2	1:A:15:HIS:HD2	1.87	0.57
1:A:145:GLU:OE1	1:A:208:ARG:CD	2.52	0.57
1:A:170:GLU:HB3	1:A:178:ILE:HB	1.86	0.57
1:A:172:LEU:H	1:A:172:LEU:HD23	1.70	0.56
1:A:373:CYS:HB2	1:A:374:PRO:HD2	1.88	0.56
1:B:183:MET:HE1	1:B:247:HIS:CG	2.41	0.56
1:B:132[B]:GLU:OE1	2:B:401:HOH:O	2.18	0.55
1:B:226:LYS:HD3	1:B:275:ASP:HB3	1.87	0.55
1:A:175:ASN:HB3	1:A:177:VAL:O	2.07	0.54
1:A:314:VAL:HG21	2:A:501:HOH:O	2.07	0.54
1:B:306:TRP:HA	1:B:343[B]:MET:SD	2.48	0.54
1:B:2:ASN:N	1:B:2:ASN:ND2	2.56	0.53
1:B:95:TYR:CE2	1:B:104:PRO:HG3	2.47	0.50
1:A:54:ARG:HD3	1:A:373:CYS:SG	2.52	0.49
1:A:142:LYS:NZ	2:A:403:HOH:O	2.46	0.49
1:B:106:ASP:OD1	1:B:108:ARG:CD	2.61	0.49
1:B:145:GLU:OE1	1:B:208:ARG:HD2	2.12	0.49
1:A:170:GLU:HA	1:A:179:ALA:O	2.12	0.48
1:A:58:ALA:HB3	2:A:407:HOH:O	2.14	0.48
1:A:167[B]:GLN:O	1:A:169:ASN:N	2.46	0.48
1:A:183:MET:HE1	1:A:247:HIS:CG	2.49	0.48
1:A:363:THR:HG22	1:A:365:ARG:HG3	1.96	0.47
1:A:214:ASP:OD1	1:A:269:TYR:OH	2.33	0.47
1:A:24:LYS:NZ	1:A:26:ASP:OD1	2.44	0.47
1:B:106:ASP:OD1	1:B:108:ARG:HD3	2.15	0.47
1:B:130:ASN:OD1	1:B:132[B]:GLU:HB3	2.15	0.47
1:B:150:ASN:OD1	1:B:152:GLU:HB3	2.16	0.45
1:B:151:GLU:H	1:B:151:GLU:CD	2.26	0.44
1:B:373:CYS:CB	1:B:374:PRO:CD	2.89	0.44
1:B:213:ILE:HD13	1:B:259:LEU:HD23	2.00	0.44
1:A:266:ASP:OD1	1:A:268:LYS:HG2	2.18	0.43
1:A:33:GLY:O	1:A:369:GLY:HA2	2.18	0.43
1:A:172:LEU:HD23	1:A:172:LEU:N	2.34	0.43
1:B:223:LYS:O	1:B:224:GLN:HG2	2.19	0.43
1:A:361:GLN:HE21	1:A:361:GLN:HA	1.85	0.41
1:A:130:ASN:OD1	1:A:132:GLU:HB3	2.21	0.41
1:A:54:ARG:CD	1:A:373:CYS:SG	3.09	0.41
1:A:373:CYS:CB	1:A:374:PRO:CD	2.99	0.41

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Atom-1	Atom-2	Interatomic distance (Å)	Clash overlap (Å)
1:B:97:MET:HE3	1:B:97:MET:HB2	1.93	0.41
1:A:145:GLU:OE1	1:A:208:ARG:HD2	2.21	0.41
1:B:88:ASP:O	1:B:92:LYS:HA	2.20	0.40
1:B:231:PHE:O	1:B:238:SER:HA	2.22	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:B:430:HOH:O	2:B:430:HOH:O[2_656]	1.75	0.45

5.3 Torsion angles

5.3.1 Protein backbone

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	392/390 (100%)	375 (96%)	14 (4%)	3 (1%)	16	6
1	B	392/390 (100%)	375 (96%)	12 (3%)	5 (1%)	9	2
All	All	784/780 (100%)	750 (96%)	26 (3%)	8 (1%)	12	4

All (8) Ramachandran outliers are listed below:

Mol	Chain	Res	Type
1	A	168	SER
1	A	174	GLU
1	A	172	LEU
1	B	172	LEU
1	B	177	VAL
1	B	224	GLN
1	B	168	SER
1	B	176	GLY

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	344/339 (102%)	333 (97%)	11 (3%)	34	19
1	B	342/339 (101%)	325 (95%)	17 (5%)	22	8
All	All	686/678 (101%)	658 (96%)	28 (4%)	27	12

All (28) residues with a non-rotameric sidechain are listed below:

Mol	Chain	Res	Type
1	A	142	LYS
1	A	169	ASN
1	A	170	GLU
1	A	171	MET
1	A	172	LEU
1	A	178	ILE
1	A	199	VAL
1	A	223	LYS
1	A	330	LYS
1	A	375	TYR
1	A	380	PHE
1	B	2	ASN
1	B	3	THR
1	B	97	MET
1	B	142	LYS
1	B	161	ASN
1	B	171	MET
1	B	175	ASN
1	B	203	GLU
1	B	223	LYS
1	B	224	GLN
1	B	226	LYS
1	B	238	SER
1	B	261	VAL
1	B	329	LEU
1	B	330	LYS
1	B	375	TYR

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Mol	Chain	Res	Type
1	B	380	PHE

Sometimes sidechains can be flipped to improve hydrogen bonding and reduce clashes. All (10) such sidechains are listed below:

Mol	Chain	Res	Type
1	A	15	HIS
1	A	28	ASN
1	A	73	GLN
1	A	271	GLN
1	A	361	GLN
1	B	2	ASN
1	B	15	HIS
1	B	73	GLN
1	B	89	HIS
1	B	131	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 ⓘ

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	388/390 (99%)	0.23	18 (4%) 37 40	12, 29, 51, 137	6 (1%)
1	B	389/390 (99%)	0.42	23 (5%) 28 31	10, 31, 64, 170	5 (1%)
All	All	777/780 (99%)	0.33	41 (5%) 32 35	10, 30, 58, 170	11 (1%)

All (41) RSRZ outliers are listed below:

Mol	Chain	Res	Type	RSRZ
1	A	172	LEU	7.5
1	B	177	VAL	6.7
1	B	172	LEU	6.7
1	B	171	MET	6.4
1	A	171	MET	6.2
1	A	177	VAL	6.0
1	A	169	ASN	5.3
1	B	169	ASN	4.6
1	B	1	MET	4.5
1	A	4	PHE	4.0
1	B	168	SER	3.9
1	B	173	SER	3.7
1	B	236	TRP	3.4
1	A	298	GLY	3.4
1	B	224	GLN	3.3
1	B	178	ILE	3.3
1	B	4	PHE	3.3
1	A	176	GLY	3.3
1	A	178	ILE	3.2
1	A	168	SER	3.1
1	B	240	ILE	3.1
1	B	176	GLY	3.1
1	A	1	MET	3.0
1	B	389	GLY	3.0

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Mol	Chain	Res	Type	RSRZ
1	A	175	ASN	3.0
1	B	239	ILE	2.9
1	B	170	GLU	2.7
1	B	235	HIS	2.6
1	A	173	SER	2.6
1	A	235	HIS	2.5
1	A	167[A]	GLN	2.5
1	A	388	VAL	2.4
1	B	203	GLU	2.4
1	B	233	ASN	2.4
1	A	240	ILE	2.3
1	A	170	GLU	2.3
1	A	358	ALA	2.2
1	B	167	GLN	2.2
1	B	175	ASN	2.1
1	B	300	ILE	2.0
1	B	3	THR	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](#)

There are no ligands in this entry.

6.5 Other polymers [i](#)

There are no such residues in this entry.