Full wwPDB X-ray Structure Validation Report (i)

Jun 17, 2024 – 03:34 AM EDT

PDB ID	:	3O66
Title	:	Crystal structure of glycine betaine/carnitine/choline ABC transporter
Authors	:	Chang, C.; Bigelow, L.; Carroll, J.; Joachimiak, A.; Midwest Center for Structural Genomics (MCSG)
Deposited on	:	2010-07-28
Resolution	:	1.86 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 (i) 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 (i)) were used in the production of this report:

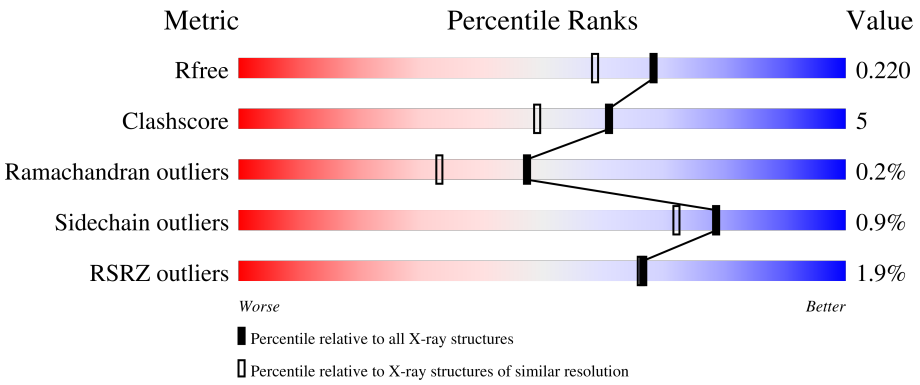
MolProbity	:	4.02b-467
Mogul	:	2022.3.0, CSD as543be (2022)
Xtriage (Phenix)	:	1.20.1
EDS	:	2.37.1
Percentile statistics	:	20191225.v01 (using entries in the PDB archive December 25th 2019)
Refmac	:	5.8.0158
CCP4	:	7.0.044 (Gargrove)
Ideal geometry (proteins)	:	Engh & Huber (2001)
Ideal geometry (DNA, RNA)	:	Parkinson et al. (1996)
Validation Pipeline (wwPDB-VP)	:	2.37.1

1 Overall quality at a glance (i)

The following experimental techniques were used to determine the structure:
X-RAY DIFFRACTION

The reported resolution of this entry is 1.86 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}	130704	2469 (1.86-1.86)
Clashscore	141614	2625 (1.86-1.86)
Ramachandran outliers	138981	2592 (1.86-1.86)
Sidechain outliers	138945	2592 (1.86-1.86)
RSRZ outliers	127900	2436 (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 <=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	282	2% 89% 8%
1	B	282	% 93%

2 Entry composition (i)

There are 4 unique types of molecules in this entry. The entry contains 4887 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.

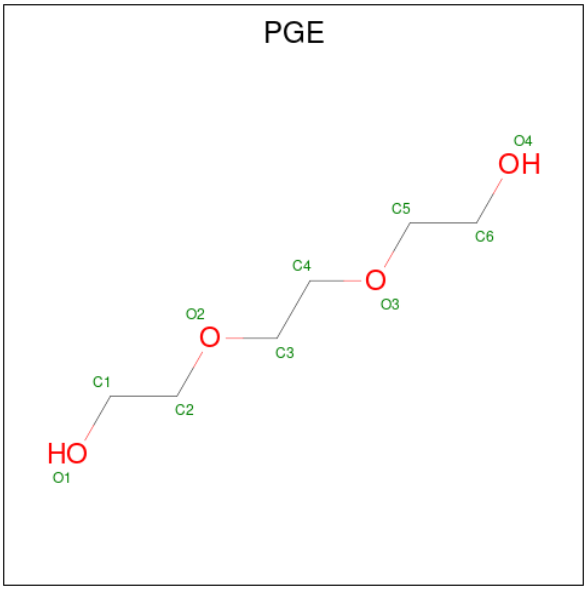
- Molecule 1 is a protein called Glycine betaine/carnitine/choline ABC transporter.

Mol	Chain	Residues	Atoms					ZeroOcc	AltConf	Trace
			Total	C	N	O	Se			
1	A	274	2239	1419	378	435	7	0	10	0
1	B	272	2174	1381	366	420	7	0	4	0

There are 6 discrepancies between the modelled and reference sequences:

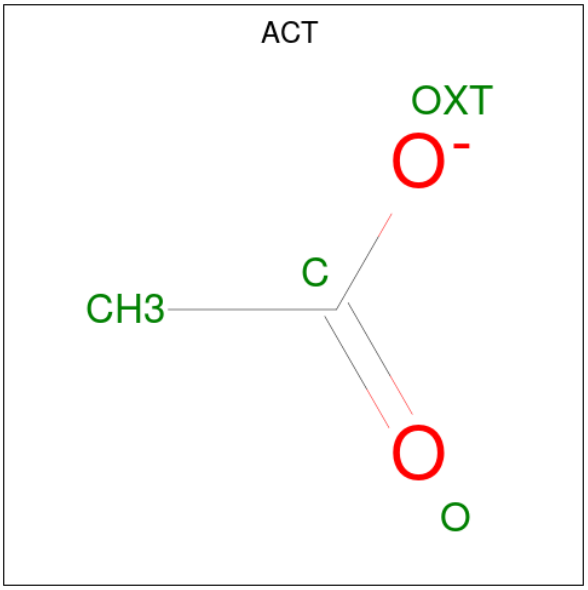
Chain	Residue	Modelled	Actual	Comment	Reference
A	25	SER	-	EXPRESSION TAG	UNP Q99RI5
A	26	ASN	-	EXPRESSION TAG	UNP Q99RI5
A	27	ALA	-	EXPRESSION TAG	UNP Q99RI5
B	25	SER	-	EXPRESSION TAG	UNP Q99RI5
B	26	ASN	-	EXPRESSION TAG	UNP Q99RI5
B	27	ALA	-	EXPRESSION TAG	UNP Q99RI5

- Molecule 2 is TRIETHYLENE GLYCOL (three-letter code: PGE) (formula: $C_6H_{14}O_4$).



Mol	Chain	Residues	Atoms			ZeroOcc	AltConf
			Total	C	O		
2	A	1	20	12	8	0	1
			Total	C	O		
2	B	1	10	6	4	0	0

- Molecule 3 is ACETATE ION (three-letter code: ACT) (formula: $C_2H_3O_2$).



Mol	Chain	Residues	Atoms			ZeroOcc	AltConf
			Total	C	O		
3	A	1	4	2	2	0	0
			Total	C	O		
3	B	1	4	2	2	0	0

- Molecule 4 is water.

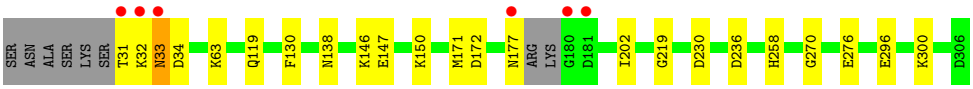
Mol	Chain	Residues	Atoms		ZeroOcc	AltConf
			Total	O		
4	A	235	235	235	0	0
			Total	O		
4	B	201	201	201	0	0

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.

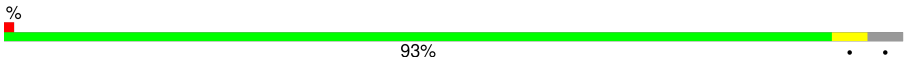
• Molecule 1: Glycine betaine/carnitine/choline ABC transporter

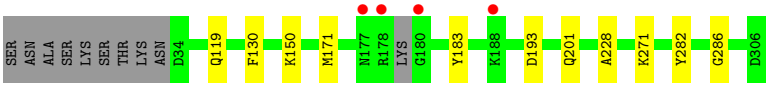
Chain A:



• Molecule 1: Glycine betaine/carnitine/choline ABC transporter

Chain B:





4 Data and refinement statistics (i)

Property	Value	Source
Space group	P 1 21 1	Depositor
Cell constants a, b, c, α, β, γ	53.19Å 114.04Å 55.89Å 90.00° 109.28° 90.00°	Depositor
Resolution (Å)	50.00 – 1.86 41.39 – 1.86	Depositor EDS
% Data completeness (in resolution range)	99.1 (50.00-1.86) 99.1 (41.39-1.86)	Depositor EDS
R_{merge}	0.10	Depositor
R_{sym}	(Not available)	Depositor
$< I/\sigma(I) >$ [1]	1.52 (at 1.86Å)	Xtriage
Refinement program	REFMAC 5.5.0109	Depositor
R, R_{free}	0.176 , 0.221 0.181 , 0.220	Depositor DCC
R_{free} test set	2655 reflections (5.08%)	wwPDB-VP
Wilson B-factor (Å^2)	27.8	Xtriage
Anisotropy	0.331	Xtriage
Bulk solvent k_{sol}(e/Å^3), B_{sol}(Å^2)	0.33 , 41.2	EDS
L-test for twinning[2]	$< \|L\| > = 0.50$, $< L^2 > = 0.33$	Xtriage
Estimated twinning fraction	No twinning to report.	Xtriage
F_o,F_c correlation	0.96	EDS
Total number of atoms	4887	wwPDB-VP
Average B, all atoms (Å^2)	31.0	wwPDB-VP

Xtriage's analysis on translational NCS is as follows: *The largest off-origin peak in the Patterson function is 7.27% of the height of the origin peak. No significant pseudotranslation is detected.*

[1]Intensities estimated from amplitudes.

[2]Theoretical values of $< |L| >$, $< L^2 >$ 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)

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

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	0.67	0/2273	0.65	1/3043 (0.0%)
1	B	0.64	0/2210	0.66	0/2963
All	All	0.66	0/4483	0.66	1/6006 (0.0%)

There are no bond length outliers.

All (1) bond angle outliers are listed below:

Mol	Chain	Res	Type	Atoms	Z	Observed(^{o})	Ideal(^{o})
1	A	236	ASP	CB-CG-OD1	5.72	123.45	118.30

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	2239	0	2207	22	0
1	B	2174	0	2146	13	0
2	A	20	0	28	3	0
2	B	10	0	14	3	0
3	A	4	0	3	0	0
3	B	4	0	3	1	0
4	A	235	0	0	6	0
4	B	201	0	0	10	0

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Mol	Chain	Non-H	H(model)	H(added)	Clashes	Symm-Clashes
All	All	4887	0	4401	40	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 5.

All (40) 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:31:THR:O	1:A:63:LYS:HB3	1.66	0.96
2:A:321[B]:PGE:H3	4:A:399:HOH:O	1.78	0.83
1:A:146[B]:LYS:HG2	1:A:230:ASP:O	1.86	0.76
1:A:33:ASN:CG	1:A:34[B]:ASP:H	1.95	0.69
1:A:172:ASP:OD1	4:A:402:HOH:O	2.09	0.69
1:A:296[B]:GLU:OE2	1:A:300:LYS:HE2	1.93	0.69
1:B:228:ALA:HB2	1:B:282[A]:TYR:CE1	2.27	0.69
1:B:282[B]:TYR:HE2	4:B:387:HOH:O	1.77	0.67
2:A:321[B]:PGE:H32	4:A:336:HOH:O	1.96	0.65
1:A:33:ASN:CG	1:A:34[A]:ASP:H	2.00	0.64
1:A:276[B]:GLU:HG3	4:A:5:HOH:O	1.98	0.63
1:A:202:ILE:HD11	1:A:219:GLY:HA2	1.82	0.62
3:B:322:ACT:H3	4:B:358:HOH:O	2.01	0.61
1:A:33:ASN:HB3	1:A:258:HIS:NE2	2.16	0.60
2:B:321:PGE:H62	4:B:332:HOH:O	2.01	0.60
1:A:296[B]:GLU:OE2	1:A:300:LYS:CE	2.50	0.58
1:A:32:LYS:O	1:A:33:ASN:HB2	2.04	0.57
1:B:282[B]:TYR:CE2	4:B:387:HOH:O	2.53	0.57
1:B:193[B]:ASP:OD1	4:B:354:HOH:O	2.17	0.57
1:A:138:ASN:O	2:A:321[A]:PGE:H42	2.04	0.56
2:B:321:PGE:H6	4:B:337:HOH:O	2.06	0.55
1:A:33:ASN:ND2	1:A:34[A]:ASP:H	2.06	0.54
1:A:31:THR:O	1:A:63:LYS:CB	2.49	0.53
1:A:270:GLY:O	1:B:271:LYS:HD3	2.10	0.51
1:B:282[A]:TYR:HD1	4:B:493:HOH:O	1.93	0.51
1:B:119:GLN:HG2	1:B:130:PHE:O	2.13	0.49
1:B:228:ALA:HB2	1:B:282[A]:TYR:CZ	2.47	0.49
2:B:321:PGE:H4	4:B:21:HOH:O	2.13	0.48
1:A:296[B]:GLU:OE2	1:A:300:LYS:NZ	2.47	0.48
1:B:193[A]:ASP:OD1	4:B:365:HOH:O	2.20	0.47
1:A:33:ASN:CG	1:A:34[A]:ASP:N	2.66	0.46
1:A:33:ASN:CG	1:A:34[B]:ASP:N	2.66	0.46
1:B:183:TYR:OH	1:B:193[B]:ASP:OD1	2.23	0.46

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Atom-1	Atom-2	Interatomic distance (Å)	Clash overlap (Å)
1:A:150[A]:LYS:HG3	4:A:350:HOH:O	2.17	0.44
1:B:282[A]:TYR:CE1	1:B:286:GLY:HA3	2.52	0.44
1:B:201:GLN:HG3	4:B:333:HOH:O	2.18	0.43
1:A:33:ASN:ND2	1:A:34[B]:ASP:H	2.16	0.43
1:A:147[B]:GLU:HG3	4:A:316:HOH:O	2.17	0.43
1:B:228:ALA:HB2	1:B:282[A]:TYR:CD1	2.54	0.42
1:A:119:GLN:HG2	1:A:130:PHE:O	2.22	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	280/282 (99%)	277 (99%)	2 (1%)	1 (0%)	34 19
1	B	272/282 (96%)	270 (99%)	2 (1%)	0	100 100
All	All	552/564 (98%)	547 (99%)	4 (1%)	1 (0%)	47 33

All (1) Ramachandran outliers are listed below:

Mol	Chain	Res	Type
1	A	33	ASN

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	239/232 (103%)	237 (99%)	2 (1%)	81	76
1	B	232/232 (100%)	229 (99%)	3 (1%)	69	58
All	All	471/464 (102%)	466 (99%)	5 (1%)	78	65

All (5) residues with a non-rotameric sidechain are listed below:

Mol	Chain	Res	Type
1	A	171	MSE
1	A	177	ASN
1	B	150[A]	LYS
1	B	150[B]	LYS
1	B	171	MSE

Sometimes sidechains can be flipped to improve hydrogen bonding and reduce clashes. All (2) such sidechains are listed below:

Mol	Chain	Res	Type
1	A	33	ASN
1	A	177	ASN

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 monosaccharides in this entry.

5.6 Ligand geometry (i)

5 ligands are modelled in this entry.

In the following table, the Counts columns list the number of bonds (or angles) for which Mogul statistics could be retrieved, the number of bonds (or angles) that are observed in the model and the number of bonds (or angles) that are defined in the Chemical Component Dictionary. The Link column lists molecule types, if any, to which the group is linked. 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 $|Z| > 2$ is considered an outlier worth inspection. RMSZ is the root-mean-square of all Z scores of the bond lengths (or angles).

Mol	Type	Chain	Res	Link	Bond lengths			Bond angles		
					Counts	RMSZ	$\#\|Z\| > 2$	Counts	RMSZ	$\#\|Z\| > 2$
2	PGE	A	321[B]	-	9,9,9	0.43	0	8,8,8	0.24	0
3	ACT	A	323	-	3,3,3	0.82	0	3,3,3	1.08	0
3	ACT	B	322	-	3,3,3	0.91	0	3,3,3	1.02	0
2	PGE	B	321	-	9,9,9	0.33	0	8,8,8	0.52	0
2	PGE	A	321[A]	-	9,9,9	0.42	0	8,8,8	0.25	0

In the following table, the Chirals column lists the number of chiral outliers, the number of chiral centers analysed, the number of these observed in the model and the number defined in the Chemical Component Dictionary. Similar counts are reported in the Torsion and Rings columns. '-' means no outliers of that kind were identified.

Mol	Type	Chain	Res	Link	Chirals	Torsions	Rings
2	PGE	A	321[B]	-	-	5/7/7/7	-
2	PGE	A	321[A]	-	-	3/7/7/7	-
2	PGE	B	321	-	-	3/7/7/7	-

There are no bond length outliers.

There are no bond angle outliers.

There are no chirality outliers.

All (11) torsion outliers are listed below:

Mol	Chain	Res	Type	Atoms
2	B	321	PGE	O2-C3-C4-O3
2	A	321[B]	PGE	O1-C1-C2-O2
2	B	321	PGE	C6-C5-O3-C4
2	A	321[B]	PGE	C4-C3-O2-C2
2	A	321[A]	PGE	C3-C4-O3-C5
2	A	321[B]	PGE	C6-C5-O3-C4
2	B	321	PGE	C4-C3-O2-C2
2	A	321[B]	PGE	C1-C2-O2-C3
2	A	321[A]	PGE	C6-C5-O3-C4
2	A	321[A]	PGE	C4-C3-O2-C2
2	A	321[B]	PGE	O2-C3-C4-O3

There are no ring outliers.

4 monomers are involved in 7 short contacts:

Mol	Chain	Res	Type	Clashes	Symm-Clashes
2	A	321[B]	PGE	2	0
3	B	322	ACT	1	0
2	B	321	PGE	3	0
2	A	321[A]	PGE	1	0

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	267/282 (94%)	-0.25	6 (2%)	62	61	19, 28, 43, 68	0
1	B	265/282 (93%)	-0.27	4 (1%)	73	74	22, 31, 44, 65	0
All	All	532/564 (94%)	-0.26	10 (1%)	66	66	19, 30, 44, 68	0

All (10) RSRZ outliers are listed below:

Mol	Chain	Res	Type	RSRZ
1	A	31	THR	8.4
1	A	32	LYS	4.4
1	A	33	ASN	3.9
1	A	180	GLY	2.9
1	A	181	ASP	2.8
1	B	177	ASN	2.8
1	B	180	GLY	2.7
1	B	188	LYS	2.5
1	B	178	ARG	2.4
1	A	177	ASN	2.2

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 monosaccharides 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.

Mol	Type	Chain	Res	Atoms	RSCC	RSR	B-factors(Å^2)	Q<0.9
3	ACT	A	323	4/4	0.60	0.28	46,46,46,46	0
3	ACT	B	322	4/4	0.87	0.16	49,49,49,49	0
2	PGE	B	321	10/10	0.90	0.20	47,49,51,52	0
2	PGE	A	321[B]	10/10	0.92	0.23	46,47,48,50	10
2	PGE	A	321[A]	10/10	0.92	0.23	46,47,48,49	10

6.5 Other polymers (i)

There are no such residues in this entry.