



Full wwPDB X-ray Structure Validation Report ⓘ

Mar 1, 2014 – 02:32 AM GMT

PDB ID : 4EZ8
Title : Crystal structure of mouse thymidylate synthase in ternary complex with N(4)-hydroxy-2'-deoxycytidine-5'-monophosphate and the cofactor product, dihydrofolate
Authors : Dowiercial, A.; Jarmula, A.; Rypniewski, W.; Wilk, P.; Kierdaszuk, B.; Banaszak, K.; Gorecka, K.; Rode, W.
Deposited on : 2012-05-02
Resolution : 1.17 Å (reported)

This is a full wwPDB validation report for a publicly released PDB entry.
We welcome your comments at validation@mail.wwpdb.org
A user guide is available at <http://wwpdb.org/ValidationPDFNotes.html>

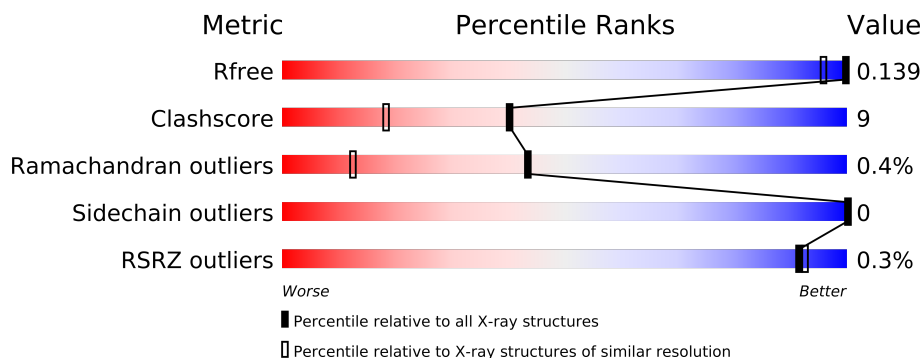
The following versions of software and data (see [references](#)) were used in the production of this report:

MolProbity : 4.02b-467
Mogul : 1.15 2013
Xtriage (Phenix) : dev-1323
EDS : stable22639
Percentile statistics : 21963
Refmac : 5.8.0049
CCP4 : 6.3.0 (Settle)
Ideal geometry (proteins) : Engh & Huber (2001)
Ideal geometry (DNA, RNA) : Parkinson et. al. (1996)
Validation Pipeline (wwPDB-VP) : stable22683

1 Overall quality at a glance


The reported resolution of this entry is 1.17 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}	66092	1374 (1.26-1.10)
Clashscore	79885	1528 (1.26-1.10)
Ramachandran outliers	78287	1454 (1.26-1.10)
Sidechain outliers	78261	1449 (1.26-1.10)
RSRZ outliers	66119	1374 (1.26-1.10)

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 on the lower bar indicate the fraction of residues that contain outliers for ≥ 3 , 2, 1 and 0 types of geometric quality criteria. The upper red bar (where present) indicates the fraction of residues that have poor fit to the electron density.

Mol	Chain	Length	Quality of chain
1	A	307	

2 Entry composition i

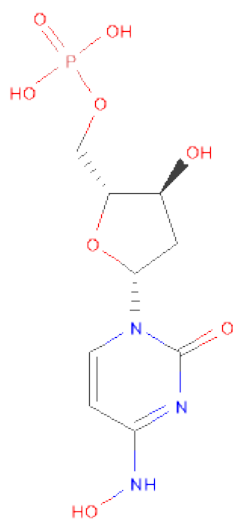
There are 5 unique types of molecules in this entry. The entry contains 3141 atoms, of which 0 are hydrogen and 0 are deuterium.

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 Thymidylate synthase.

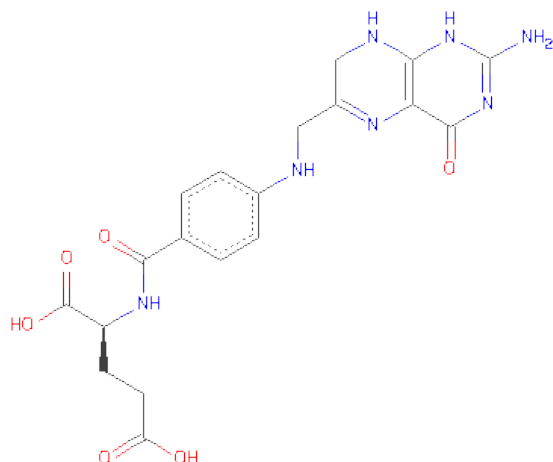
Mol	Chain	Residues	Atoms					ZeroOcc	AltConf	Trace
			Total	C	N	O	S			
1	A	287	2598	1657	452	474	15	0	34	0

- Molecule 2 is 2'-DEOXY-N-HYDROXYCYTIDINE5'-(DIHYDROGEN PHOSPHATE) (three-letter code: NOH) (formula: C₉H₁₄N₃O₈P).



Mol	Chain	Residues	Atoms					ZeroOcc	AltConf
			Total	C	N	O	P		
2	A	1	21	9	3	8	1	0	0

- Molecule 3 is DIHYDROFOLIC ACID (three-letter code: DHF) (formula: C₁₉H₂₁N₇O₆).



Mol	Chain	Residues	Atoms				ZeroOcc	AltConf
3	A	1	Total	C	N	O	0	0
			32	19	7	6		

- Molecule 4 is GLYCEROL (three-letter code: GOL) (formula: C₃H₈O₃).



Mol	Chain	Residues	Atoms			ZeroOcc	AltConf
4	A	1	Total	C	O	0	0
			6	3	3		
4	A	1	Total	C	O	0	0
			6	3	3		

- Molecule 5 is water.

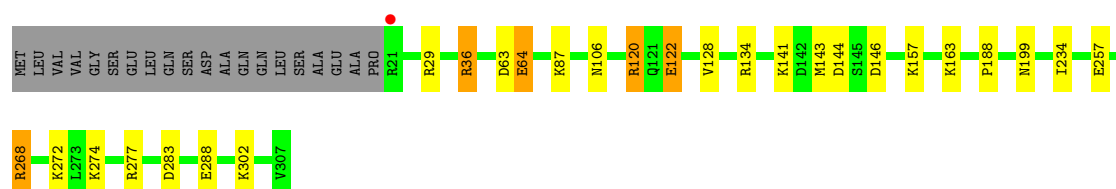
Mol	Chain	Residues	Atoms		ZeroOcc	AltConf
5	A	478	Total 478	O 478	0	0

3 Residue-property plots

These plots are drawn for all protein, RNA and DNA chains in the entry. The first graphic for a chain summarises the proportions of errors 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: Thymidylate synthase

Chain A: 



4 Data and refinement statistics

Property	Value	Source
Space group	C 2 2 21	Depositor
Cell constants a, b, c, α , β , γ	71.12Å 112.05Å 88.30Å 90.00° 90.00° 90.00°	Depositor
Resolution (Å)	21.35 – 1.17 21.35 – 1.17	Depositor EDS
% Data completeness (in resolution range)	99.0 (21.35-1.17) 99.0 (21.35-1.17)	Depositor EDS
R_{merge}	0.08	Depositor
R_{sym}	(Not available)	Depositor
$\langle I/\sigma(I) \rangle$ ¹	2.11 (at 1.17Å)	Xtriage
Refinement program	REFMAC 5.5.0109	Depositor
R, R_{free}	0.107 , 0.130 0.122 , 0.139	Depositor DCC
R_{free} test set	5872 reflections (5.27%)	DCC
Wilson B-factor (Å ²)	9.4	Xtriage
Anisotropy	0.032	Xtriage
Bulk solvent k_{sol} (e/Å ³), B_{sol} (Å ²)	0.38 , 48.0	EDS
Estimated twinning fraction	No twinning to report.	Xtriage
L-test for twinning	$\langle L \rangle = 0.50$, $\langle L^2 \rangle = 0.34$	Xtriage
Outliers	0 of 117324 reflections	Xtriage
F_o, F_c correlation	0.98	EDS
Total number of atoms	3141	wwPDB-VP
Average B, all atoms (Å ²)	15.0	wwPDB-VP

Xtriage's analysis on translational NCS is as follows: *The largest off-origin peak in the Patterson function is 5.36% of the height of the origin peak. No significant pseudotranslation is detected.*

¹Intensities estimated from amplitudes.

5 Model quality

5.1 Standard geometry

Bond lengths and bond angles in the following residue types are not validated in this section: GOL, NOH, DHF

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	1.05	10/2692 (0.4%)	1.06	13/3624 (0.4%)

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

All (10) bond length outliers are listed below:

Mol	Chain	Res	Type	Atoms	Z	Observed(Å)	Ideal(Å)
1	A	122[A]	GLU	CD-OE2	-7.88	1.17	1.25
1	A	122[B]	GLU	CD-OE2	-7.88	1.17	1.25
1	A	288[A]	GLU	CD-OE2	6.01	1.32	1.25
1	A	288[B]	GLU	CD-OE2	6.01	1.32	1.25
1	A	257	GLU	CD-OE2	6.00	1.32	1.25
1	A	120[A]	ARG	CB-CG	-5.61	1.37	1.52
1	A	120[B]	ARG	CB-CG	-5.61	1.37	1.52
1	A	87	LYS	CE-NZ	5.37	1.62	1.49
1	A	283[A]	ASP	CG-OD1	5.09	1.37	1.25
1	A	283[B]	ASP	CG-OD1	5.09	1.37	1.25

All (13) bond angle outliers are listed below:

Mol	Chain	Res	Type	Atoms	Z	Observed(°)	Ideal(°)
1	A	36[A]	ARG	NE-CZ-NH1	-13.58	113.51	120.30
1	A	36[B]	ARG	NE-CZ-NH1	-13.58	113.51	120.30
1	A	268	ARG	NE-CZ-NH1	-11.12	114.74	120.30

Continued on next page...

Continued from previous page...

Mol	Chain	Res	Type	Atoms	Z	Observed(°)	Ideal(°)
1	A	277	ARG	NE-CZ-NH2	7.15	123.88	120.30
1	A	283[A]	ASP	CB-CG-OD2	-5.73	113.14	118.30
1	A	283[B]	ASP	CB-CG-OD2	-5.73	113.14	118.30
1	A	64[A]	GLU	OE1-CD-OE2	5.47	129.87	123.30
1	A	64[B]	GLU	OE1-CD-OE2	5.47	129.87	123.30
1	A	36[A]	ARG	NH1-CZ-NH2	5.18	125.10	119.40
1	A	36[B]	ARG	NH1-CZ-NH2	5.18	125.10	119.40
1	A	134[A]	ARG	NE-CZ-NH2	-5.09	117.75	120.30
1	A	134[B]	ARG	NE-CZ-NH2	-5.09	117.75	120.30
1	A	146	ASP	CB-CG-OD1	5.05	122.84	118.30

There are no chirality outliers.

All (1) planarity outliers are listed below:

Mol	Chain	Res	Type	Group
1	A	268	ARG	Sidechain

5.2 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 hydrogens added by MolProbity. The Clashes column lists the number of clashes within the asymmetric unit, and the number in parentheses is this value normalized per 1000 atoms of the molecule in the chain. The Symm-Clashes column gives symmetry related clashes, in the same way as for the Clashes column.

Mol	Chain	Non-H	H(model)	H(added)	Clashes	Symm-Clashes
1	A	2598	0	0	24	1
2	A	21	0	0	0	0
3	A	32	0	0	0	0
4	A	12	0	0	2	0
5	A	478	0	0	23	1
All	All	3141	0	0	25	1

Clashscore is defined as the number of clashes calculated for the entry per 1000 atoms (including hydrogens) of the entry. The overall clashscore for this entry is 9.

All (25) close contacts within the same asymmetric unit are listed below.

Atom-1	Atom-2	Distance(Å)	Clash(Å)
1:A:199[A]:ASN:ND2	5:A:933:HOH:O	1.73	1.21
1:A:106[B]:ASN:ND2	5:A:838:HOH:O	1.85	1.07

Continued on next page...

Continued from previous page...

Atom-1	Atom-2	Distance(Å)	Clash(Å)
1:A:64[B]:GLU:OE1	5:A:832:HOH:O	1.76	1.03
1:A:64[A]:GLU:OE1	5:A:833:HOH:O	1.77	1.02
1:A:63[A]:ASP:OD1	5:A:939:HOH:O	1.79	1.00
1:A:272:LYS:NZ	5:A:889:HOH:O	1.99	0.95
1:A:302[A]:LYS:CD	5:A:920:HOH:O	2.14	0.94
1:A:120[B]:ARG:CD	5:A:567:HOH:O	2.18	0.91
1:A:234[B]:ILE:CG2	5:A:902:HOH:O	2.35	0.74
1:A:36[A]:ARG:CG	5:A:959:HOH:O	2.36	0.74
1:A:199[B]:ASN:OD1	4:A:403:GOL:O3	2.07	0.73
1:A:36[B]:ARG:NH1	5:A:962:HOH:O	2.22	0.73
1:A:122[B]:GLU:OE1	5:A:755:HOH:O	2.10	0.70
1:A:122[B]:GLU:CD	5:A:622:HOH:O	2.32	0.68
1:A:274[A]:LYS:CD	5:A:743:HOH:O	2.41	0.68
1:A:157[B]:LYS:CG	5:A:734:HOH:O	2.48	0.62
1:A:188[A]:PRO:CG	5:A:696:HOH:O	2.49	0.60
4:A:403:GOL:C3	5:A:721:HOH:O	2.50	0.59
1:A:199[A]:ASN:CG	5:A:933:HOH:O	2.28	0.52
1:A:143[B]:MET:CE	1:A:144[B]:ASP:OD2	2.58	0.52
1:A:274[A]:LYS:CE	5:A:743:HOH:O	2.62	0.47
1:A:29[B]:ARG:NH1	5:A:780:HOH:O	2.48	0.45
1:A:163:LYS:NZ	5:A:902:HOH:O	2.50	0.45
1:A:122[B]:GLU:CG	5:A:622:HOH:O	2.66	0.43
1:A:141[B]:LYS:CE	5:A:654:HOH:O	2.66	0.43

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	Distance(Å)	Clash(Å)
1:A:36[A]:ARG:NH2	5:A:678:HOH:O[3_655]	1.73	0.47

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	319/307 (104%)	310 (97%)	8 (2%)	1 (0%)	50 18

All (1) Ramachandran outliers are listed below:

Mol	Chain	Res	Type
1	A	128	VAL

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	285/266 (107%)	285 (100%)	0	100	100

There are no protein residues with a non-rotameric sidechain to report.

Some sidechains can be flipped to improve hydrogen bonding and reduce clashes. There are no such sidechains identified.

5.3.3 RNA ⓘ

There are no RNA chains in this entry.

5.4 Non-standard residues in protein, DNA, RNA chains ⓘ

There are no non-standard protein/DNA/RNA residues in this entry.

5.5 Carbohydrates ⓘ

There are no carbohydrates in this entry.

5.6 Ligand geometry ⓘ

4 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	NOH	A	401	-	22,22,22	3.15	7 (31%)	29,32,32	3.33	9 (31%)
3	DHF	A	402	-	34,34,34	2.10	10 (29%)	45,47,47	2.21	12 (26%)
4	GOL	A	403	-	5,5,5	1.20	1 (20%)	5,5,5	4.02	2 (40%)
4	GOL	A	404	-	5,5,5	0.97	0	5,5,5	0.81	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	NOH	A	401	-	-	0/7/24/24	0/2/2/2
3	DHF	A	402	-	-	0/20/31/31	0/1/3/3
4	GOL	A	403	-	-	0/4/4/4	0/0/0/0
4	GOL	A	404	-	-	0/4/4/4	0/0/0/0

All (18) bond length outliers are listed below:

Mol	Chain	Res	Type	Atoms	Z	Observed(Å)	Ideal(Å)
2	A	401	NOH	C6-N1	9.00	1.50	1.35
2	A	401	NOH	C6-C5	7.92	1.56	1.38
3	A	402	DHF	C6-N5	6.50	1.36	1.28
2	A	401	NOH	C4-N3	5.41	1.43	1.32
3	A	402	DHF	C7-C6	-4.73	1.41	1.49
2	A	401	NOH	C4-N4	-3.96	1.27	1.37
2	A	401	NOH	C5-C4	3.87	1.48	1.39
3	A	402	DHF	C7-N8	-3.49	1.38	1.45
3	A	402	DHF	C9-C6	-2.66	1.49	1.51
3	A	402	DHF	O-C	2.62	1.28	1.23
3	A	402	DHF	OE1-CD	2.39	1.30	1.22
3	A	402	DHF	C16-C11	-2.25	1.35	1.39
2	A	401	NOH	C2-N3	2.20	1.41	1.35
3	A	402	DHF	C2-N3	2.20	1.36	1.33
3	A	402	DHF	C8A-N8	2.20	1.38	1.35
2	A	401	NOH	O4-N4	2.12	1.43	1.39
3	A	402	DHF	C15-C14	2.07	1.42	1.39
4	A	403	GOL	O2-C2	-2.06	1.37	1.43

All (23) bond angle outliers are listed below:

Mol	Chain	Res	Type	Atoms	Z	Observed(°)	Ideal(°)
2	A	401	NOH	C5-C6-N1	-12.32	107.28	121.21
2	A	401	NOH	C2-N3-C4	8.64	125.77	115.27
4	A	403	GOL	O2-C2-C3	-8.15	71.11	108.22
3	A	402	DHF	C4A-C8A-N1	6.66	123.69	114.86
3	A	402	DHF	C4-N3-C2	5.62	122.98	116.91
3	A	402	DHF	C4-C4A-C8A	5.35	118.22	114.55
2	A	401	NOH	C6-N1-C2	4.37	126.45	117.73
2	A	401	NOH	O4-N4-C4	-4.22	108.00	119.80
3	A	402	DHF	CB-CA-N	-4.07	103.08	110.83
3	A	402	DHF	C4A-C4-N3	-4.07	115.06	123.13
3	A	402	DHF	C2-N1-C8A	-3.63	116.94	122.21
4	A	403	GOL	C3-C2-C1	3.59	127.09	111.26
2	A	401	NOH	C5-C4-N3	-3.46	116.41	123.52
2	A	401	NOH	C6-C5-C4	-3.35	116.05	117.45
2	A	401	NOH	C5-C4-N4	3.30	128.01	121.53
2	A	401	NOH	C2-N1-C1'	-3.23	115.48	119.25
3	A	402	DHF	C16-C15-C14	3.15	123.94	120.27
3	A	402	DHF	C15-C16-C11	-2.39	117.90	120.76
2	A	401	NOH	OP3-P-O5'	-2.38	100.08	106.65
3	A	402	DHF	CB-CA-CT	2.29	115.63	110.71
3	A	402	DHF	C7-C6-N5	-2.15	120.94	123.02
3	A	402	DHF	OE2-CD-OE1	2.02	128.43	123.30
3	A	402	DHF	C16-C11-C12	2.01	121.51	118.63

There are no chirality outliers.

There are no torsion outliers.

There are no ring outliers.

5.7 Other polymers ⓘ

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	287/307 (93%)	-0.26	1 (0%) 91 92	5, 10, 22, 31	0

All (1) RSRZ outliers are listed below:

Mol	Chain	Res	Type	RSRZ
1	A	21[A]	ARG	5.7

6.2 Non-standard residues in protein, DNA, RNA chains ⓘ

There are no non-standard protein/DNA/RNA residues in this entry.

6.3 Carbohydrates ⓘ

There are no carbohydrates in this entry.

6.4 Ligands ⓘ

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. LLDF column lists the quality of electron density of the group with respect to its neighbouring residues in protein, DNA or RNA chains. 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	RSR	LLDF	B-factors(Å ²)	Q<0.9
4	GOL	A	404	6/6	0.13	1.88	20,26,28,28	6
3	DHF	A	402	32/32	0.09	0.79	7,12,31,40	0
4	GOL	A	403	6/6	0.09	0.75	13,18,20,23	6
2	NOH	A	401	21/21	0.04	-1.12	7,7,8,9	0

6.5 Other polymers ⓘ

There are no such residues in this entry.