



Full wwPDB X-ray Structure Validation Report ⓘ

Mar 9, 2026 – 03:06 PM UTC

PDB ID : 1B73 / pdb_00001b73
Title : GLUTAMATE RACEMASE FROM AQUIFEX PYROPHILUS
Authors : Hwang, K.Y.; Cho, C.S.; Kim, S.S.; Yu, Y.G.; Cho, Y.
Deposited on : 1999-01-26
Resolution : 2.30 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) : **NOT EXECUTED**
EDS : **NOT EXECUTED**
Percentile statistics : 20250101.v01 (using entries in the PDB archive January 1st 2025)
Ideal geometry (proteins) : Engh & Huber (2001)
Ideal geometry (DNA, RNA) : Parkinson et al. (1996)
Validation Pipeline (wwPDB-VP) : 2.49

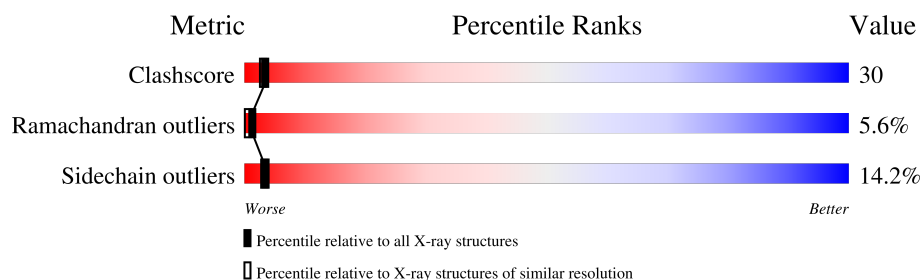
1 Overall quality at a glance

The following experimental techniques were used to determine the structure:

X-RAY DIFFRACTION

The reported resolution of this entry is 2.30 Å.

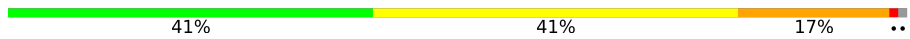
Percentile scores (ranging between 0-100) for global validation metrics of the entry are shown in the following graphic. The table shows the number of entries on which the scores are based.



Metric	Whole archive (#Entries)	Similar resolution (#Entries, resolution range(Å))
Clashscore	190562	6919 (2.30-2.30)
Ramachandran outliers	187476	6854 (2.30-2.30)
Sidechain outliers	187428	6854 (2.30-2.30)

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 $\leq 5\%$.

Note EDS was not executed.

Mol	Chain	Length	Quality of chain
1	A	254	

2 Entry composition

There are 2 unique types of molecules in this entry. The entry contains 2059 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 GLUTAMATE RACEMASE.

Mol	Chain	Residues	Atoms					ZeroOcc	AltConf	Trace
1	A	252	Total	C	N	O	S	0	0	0
			1952	1264	326	357	5			

- Molecule 2 is water.

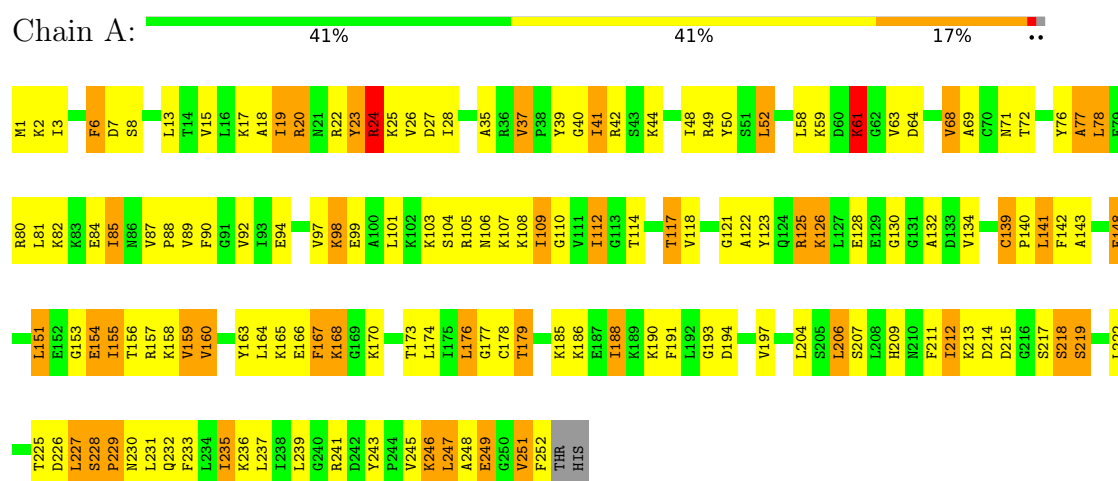
Mol	Chain	Residues	Atoms		ZeroOcc	AltConf
2	A	107	Total	O	0	0
			107	107		

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. 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. 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.

Note EDS was not executed.

• Molecule 1: GLUTAMATE RACEMASE



4 Data and refinement statistics

Xtriage (Phenix) and EDS were not executed - this section is therefore incomplete.

Property	Value	Source
Space group	P 65 2 2	Depositor
Cell constants a, b, c, α , β , γ	72.17Å 72.17Å 184.99Å 90.00° 90.00° 120.00°	Depositor
Resolution (Å)	8.00 – 2.30	Depositor
% Data completeness (in resolution range)	88.4 (8.00-2.30)	Depositor
R_{merge}	0.06	Depositor
R_{sym}	0.09	Depositor
Refinement program	X-PLOR 3.851	Depositor
R, R_{free}	0.229 , 0.284	Depositor
Estimated twinning fraction	No twinning to report.	Xtriage
Total number of atoms	2059	wwPDB-VP
Average B, all atoms (Å ²)	36.0	wwPDB-VP

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	0.89	1/1984 (0.1%)	1.37	20/2670 (0.7%)

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 (1) bond length outliers are listed below:

Mol	Chain	Res	Type	Atoms	Z	Observed(Å)	Ideal(Å)
1	A	85	ILE	CA-CB	5.53	1.60	1.54

All (20) bond angle outliers are listed below:

Mol	Chain	Res	Type	Atoms	Z	Observed(°)	Ideal(°)
1	A	159	VAL	N-CA-C	-10.24	100.79	110.42
1	A	77	ALA	N-CA-C	8.30	123.63	113.17
1	A	179	THR	N-CA-C	8.01	121.31	108.41
1	A	142	PHE	N-CA-C	7.94	123.04	113.12
1	A	37	VAL	N-CA-C	7.46	124.99	108.88
1	A	134	VAL	CB-CA-C	-6.67	102.48	111.15
1	A	24	ARG	N-CA-C	6.61	120.94	112.34
1	A	112	ILE	N-CA-C	-6.55	98.19	107.75
1	A	251	VAL	N-CA-C	-6.47	102.96	111.05
1	A	69	ALA	N-CA-C	6.41	120.81	113.19
1	A	97	VAL	N-CA-C	6.40	116.56	110.42
1	A	61	LYS	N-CA-C	-6.00	105.61	113.17
1	A	41	ILE	N-CA-C	-5.43	108.55	113.71
1	A	209	HIS	N-CA-C	5.42	117.89	111.33
1	A	219	SER	N-CA-C	5.36	117.00	110.41

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Mol	Chain	Res	Type	Atoms	Z	Observed(°)	Ideal(°)
1	A	193	GLY	N-CA-C	-5.33	105.72	112.65
1	A	90	PHE	N-CA-C	5.30	117.04	108.34
1	A	15	VAL	N-CA-C	-5.22	104.81	110.23
1	A	212	ILE	N-CA-C	5.18	116.04	108.58
1	A	132	ALA	N-CA-C	5.06	116.61	108.32

There are no chirality outliers.

All (1) planarity outliers are listed below:

Mol	Chain	Res	Type	Group
1	A	23	TYR	Sidechain

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	1952	0	2052	120	0
2	A	107	0	0	2	0
All	All	2059	0	2052	120	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 30.

All (120) 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:1:MET:HE2	1:A:212:ILE:HA	1.53	0.87
1:A:151:LEU:O	1:A:156:THR:HB	1.78	0.84
1:A:121:GLY:O	1:A:125:ARG:HG3	1.81	0.81
1:A:140:PRO:HB3	1:A:163:TYR:CE2	2.16	0.81
1:A:105:ARG:HA	1:A:105:ARG:HE	1.45	0.80
1:A:140:PRO:HB3	1:A:163:TYR:HE2	1.48	0.78
1:A:186:LYS:HD2	1:A:190:LYS:NZ	2.00	0.76
1:A:251:VAL:O	1:A:252:PHE:HB2	1.89	0.71
1:A:13:LEU:O	1:A:17:LYS:HG3	1.90	0.71

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Atom-1	Atom-2	Interatomic distance (Å)	Clash overlap (Å)
1:A:77:ALA:O	1:A:81:LEU:HG	1.92	0.70
1:A:177:GLY:C	1:A:178:CYS:SG	2.76	0.68
1:A:139:CYS:SG	1:A:178:CYS:O	2.52	0.68
1:A:176:LEU:HD21	1:A:188:ILE:HD11	1.77	0.67
1:A:78:LEU:O	1:A:82:LYS:HG3	1.95	0.67
1:A:114:THR:OG1	1:A:117:THR:HG23	1.95	0.66
1:A:178:CYS:SG	2:A:316:HOH:O	2.53	0.66
1:A:186:LYS:HD2	1:A:190:LYS:HZ3	1.61	0.65
1:A:236:LYS:HA	1:A:241:ARG:O	1.96	0.64
1:A:71:ASN:ND2	1:A:123:TYR:HE2	1.96	0.63
1:A:59:LYS:HD3	1:A:85:ILE:HG23	1.79	0.63
1:A:2:LYS:HG2	1:A:63:VAL:HG12	1.80	0.62
1:A:164:LEU:O	1:A:191:PHE:HE2	1.80	0.62
1:A:71:ASN:HD22	1:A:123:TYR:HE2	1.48	0.61
1:A:227:LEU:HD22	1:A:247:LEU:HD12	1.82	0.61
1:A:233:PHE:CE1	1:A:237:LEU:HD11	2.35	0.61
1:A:222:LEU:O	1:A:246:LYS:HE2	2.00	0.61
1:A:99:GLU:OE2	1:A:103:LYS:HG2	2.02	0.60
1:A:52:LEU:HD12	1:A:81:LEU:HD23	1.84	0.59
1:A:23:TYR:O	1:A:26:VAL:HG12	2.02	0.59
1:A:177:GLY:O	1:A:178:CYS:SG	2.61	0.58
1:A:233:PHE:CZ	1:A:237:LEU:HD11	2.38	0.58
1:A:20:ARG:NH2	1:A:219:SER:O	2.36	0.58
1:A:141:LEU:HD22	1:A:141:LEU:H	1.69	0.57
1:A:235:ILE:HG23	1:A:239:LEU:HD12	1.86	0.56
1:A:153:GLY:O	1:A:155:ILE:N	2.39	0.56
1:A:155:ILE:O	1:A:159:VAL:HG23	2.05	0.56
1:A:227:LEU:CD2	1:A:247:LEU:HD12	2.36	0.55
1:A:166:GLU:OE1	1:A:167:PHE:HE1	1.90	0.55
1:A:186:LYS:HD2	1:A:190:LYS:HZ1	1.70	0.54
1:A:25:LYS:HD2	1:A:218:SER:HB2	1.91	0.53
1:A:80:ARG:HH12	1:A:84:GLU:CD	2.17	0.53
1:A:165:LYS:O	1:A:168:LYS:HB2	2.09	0.52
1:A:228:SER:HB3	1:A:229:PRO:HD2	1.89	0.52
1:A:6:PHE:CE2	1:A:68:VAL:HB	2.43	0.52
1:A:71:ASN:ND2	1:A:123:TYR:CE2	2.78	0.51
1:A:112:ILE:O	1:A:177:GLY:HA3	2.09	0.51
1:A:82:LYS:HG2	1:A:89:VAL:HB	1.93	0.51
1:A:3:ILE:HD11	1:A:212:ILE:HD13	1.92	0.51
1:A:109:ILE:HG13	1:A:173:THR:HG22	1.94	0.50
1:A:80:ARG:NH1	1:A:80:ARG:HB3	2.27	0.50

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Atom-1	Atom-2	Interatomic distance (Å)	Clash overlap (Å)
1:A:49:ARG:NH2	1:A:50:TYR:HE1	2.09	0.50
1:A:72:THR:HA	1:A:117:THR:HG22	1.95	0.49
1:A:166:GLU:HG3	1:A:167:PHE:HD1	1.76	0.49
1:A:24:ARG:HG3	1:A:25:LYS:HG2	1.95	0.49
1:A:188:ILE:C	1:A:190:LYS:H	2.19	0.49
1:A:104:SER:HB3	1:A:107:LYS:HZ2	1.78	0.48
1:A:106:ASN:ND2	1:A:108:LYS:HB2	2.29	0.47
1:A:3:ILE:HG13	1:A:26:VAL:HG21	1.97	0.47
1:A:1:MET:HE2	1:A:212:ILE:HG12	1.96	0.47
1:A:109:ILE:HG12	1:A:110:GLY:N	2.30	0.47
1:A:48:ILE:HA	1:A:77:ALA:HB2	1.97	0.47
1:A:164:LEU:O	1:A:191:PHE:CE2	2.65	0.47
1:A:7:ASP:OD1	1:A:8:SER:N	2.45	0.46
1:A:236:LYS:NZ	2:A:358:HOH:O	2.47	0.46
1:A:35:ALA:HB2	1:A:226:ASP:HB2	1.97	0.46
1:A:249:GLU:HG2	1:A:252:PHE:CE1	2.50	0.46
1:A:44:LYS:HG3	1:A:76:TYR:CD2	2.50	0.46
1:A:1:MET:HA	1:A:64:ASP:OD2	2.16	0.46
1:A:94:GLU:HG3	1:A:98:LYS:HE3	1.98	0.46
1:A:87:VAL:HB	1:A:88:PRO:CD	2.46	0.46
1:A:166:GLU:O	1:A:170:LYS:HE3	2.16	0.45
1:A:112:ILE:O	1:A:177:GLY:CA	2.64	0.45
1:A:8:SER:HB3	1:A:39:TYR:CD2	2.52	0.45
1:A:22:ARG:NH1	1:A:206:LEU:HG	2.31	0.45
1:A:105:ARG:HE	1:A:105:ARG:CA	2.21	0.45
1:A:151:LEU:N	1:A:151:LEU:HD13	2.32	0.45
1:A:227:LEU:HD11	1:A:245:VAL:CG2	2.47	0.45
1:A:35:ALA:HB2	1:A:225:THR:O	2.17	0.44
1:A:156:THR:O	1:A:160:VAL:HG23	2.17	0.44
1:A:148:GLU:HA	1:A:151:LEU:CD2	2.47	0.44
1:A:41:ILE:HG13	1:A:42:ARG:N	2.31	0.44
1:A:104:SER:HB3	1:A:107:LYS:NZ	2.32	0.44
1:A:22:ARG:HG2	1:A:23:TYR:CZ	2.52	0.44
1:A:24:ARG:NH1	1:A:25:LYS:HD3	2.33	0.44
1:A:174:LEU:HD23	1:A:197:VAL:HG22	1.99	0.44
1:A:222:LEU:HD13	1:A:243:TYR:HB3	2.00	0.44
1:A:52:LEU:HD12	1:A:81:LEU:CD2	2.47	0.43
1:A:6:PHE:HB3	1:A:58:LEU:HD11	2.00	0.43
1:A:22:ARG:HG2	1:A:23:TYR:CE1	2.54	0.43
1:A:164:LEU:CD1	1:A:188:ILE:HG22	2.47	0.43
1:A:213:LYS:HD3	1:A:215:ASP:HB3	2.01	0.43

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Atom-1	Atom-2	Interatomic distance (Å)	Clash overlap (Å)
1:A:2:LYS:HA	1:A:27:ASP:O	2.19	0.43
1:A:81:LEU:O	1:A:85:ILE:HG12	2.19	0.42
1:A:185:LYS:O	1:A:188:ILE:HG12	2.19	0.42
1:A:39:TYR:O	1:A:41:ILE:N	2.52	0.42
1:A:164:LEU:HD11	1:A:188:ILE:HG22	2.00	0.42
1:A:18:ALA:O	1:A:19:ILE:O	2.37	0.42
1:A:59:LYS:CD	1:A:85:ILE:HG23	2.48	0.42
1:A:101:LEU:HD23	1:A:101:LEU:HA	1.89	0.42
1:A:112:ILE:O	1:A:177:GLY:N	2.52	0.41
1:A:94:GLU:OE1	1:A:126:LYS:HD3	2.21	0.41
1:A:156:THR:HG23	1:A:157:ARG:N	2.35	0.41
1:A:213:LYS:O	1:A:215:ASP:N	2.53	0.41
1:A:92:VAL:HG23	1:A:204:LEU:HD22	2.01	0.41
1:A:20:ARG:NH2	1:A:28:ILE:HG13	2.34	0.41
1:A:128:GLU:C	1:A:130:GLY:H	2.29	0.41
1:A:167:PHE:HD1	1:A:167:PHE:N	2.19	0.41
1:A:211:PHE:CD2	1:A:211:PHE:N	2.88	0.41
1:A:248:ALA:O	1:A:249:GLU:HB2	2.21	0.41
1:A:154:GLU:O	1:A:158:LYS:HG3	2.21	0.41
1:A:167:PHE:N	1:A:167:PHE:CD1	2.88	0.41
1:A:188:ILE:C	1:A:190:LYS:N	2.79	0.41
1:A:227:LEU:HD13	1:A:227:LEU:HA	1.81	0.41
1:A:148:GLU:HA	1:A:151:LEU:HD23	2.03	0.40
1:A:166:GLU:HG3	1:A:167:PHE:CD1	2.54	0.40
1:A:101:LEU:CD1	1:A:130:GLY:HA3	2.51	0.40
1:A:61:LYS:HD3	1:A:61:LYS:HA	1.92	0.40
1:A:122:ALA:HA	1:A:125:ARG:HE	1.86	0.40
1:A:143:ALA:HB2	1:A:148:GLU:OE2	2.21	0.40
1:A:151:LEU:HD12	1:A:155:ILE:CD1	2.50	0.40

There are no symmetry-related clashes.

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	250/254 (98%)	211 (84%)	25 (10%)	14 (6%)	1 0

All (14) Ramachandran outliers are listed below:

Mol	Chain	Res	Type
1	A	154	GLU
1	A	168	LYS
1	A	229	PRO
1	A	19	ILE
1	A	40	GLY
1	A	160	VAL
1	A	194	ASP
1	A	214	ASP
1	A	249	GLU
1	A	20	ARG
1	A	37	VAL
1	A	125	ARG
1	A	126	LYS
1	A	228	SER

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	211/213 (99%)	181 (86%)	30 (14%)	3 3

All (30) residues with a non-rotameric sidechain are listed below:

Mol	Chain	Res	Type
1	A	6	PHE
1	A	24	ARG
1	A	52	LEU
1	A	61	LYS
1	A	68	VAL
1	A	78	LEU
1	A	98	LYS

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Mol	Chain	Res	Type
1	A	109	ILE
1	A	117	THR
1	A	118	VAL
1	A	139	CYS
1	A	141	LEU
1	A	148	GLU
1	A	151	LEU
1	A	155	ILE
1	A	167	PHE
1	A	176	LEU
1	A	179	THR
1	A	188	ILE
1	A	206	LEU
1	A	207	SER
1	A	217	SER
1	A	218	SER
1	A	227	LEU
1	A	230	ASN
1	A	231	LEU
1	A	232	GLN
1	A	235	ILE
1	A	246	LYS
1	A	247	LEU

Sometimes sidechains can be flipped to improve hydrogen bonding and reduce clashes. All (4) such sidechains are listed below:

Mol	Chain	Res	Type
1	A	71	ASN
1	A	162	HIS
1	A	230	ASN
1	A	232	GLN

5.3.3 RNA ⓘ

There are no RNA molecules 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 [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 [i](#)

There are no chain breaks in this entry.

6 Fit of model and data

6.1 Protein, DNA and RNA chains

EDS was not executed - this section is therefore empty.

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

EDS was not executed - this section is therefore empty.

6.3 Carbohydrates

EDS was not executed - this section is therefore empty.

6.4 Ligands

EDS was not executed - this section is therefore empty.

6.5 Other polymers

EDS was not executed - this section is therefore empty.