Full wwPDB X-ray Structure Validation Report (i)

Dec 10, 2023 – 11:41 pm GMT

PDB ID	:	2BS1
Title	:	MS2 (N87AE89K mutant) - Qbeta RNA hairpin complex
Authors	:	Horn, W.T.; Tars, K.; Grahn, E.; Helgstrand, C.; Baron, A.J.; Lago, H.; Adams, C.J.; Peabody, D.S.; Phillips, S.E.V.; Stonehouse, N.J.; Liljas, L.; Stockley, P.G.
Deposited on	:	2005-05-13
Resolution	:	2.80 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 (1)) were used in the production of this report:

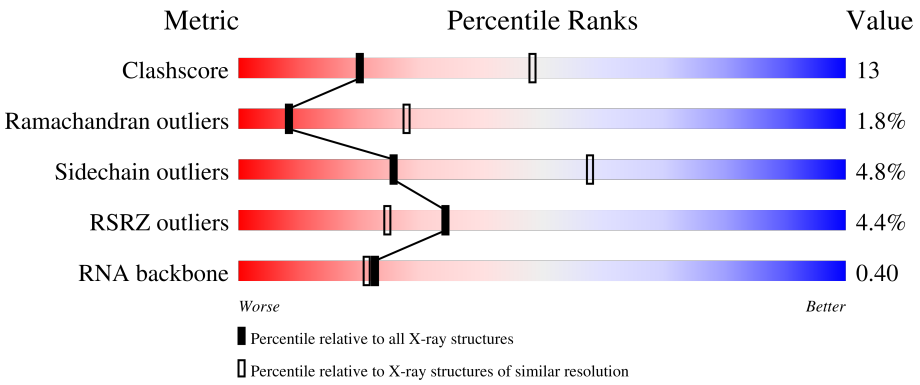
MolProbity	:	4.02b-467
Xtriage (Phenix)	:	1.13
EDS	:	2.36
Percentile statistics	:	20191225.v01 (using entries in the PDB archive December 25th 2019)
Refmac	:	5.8.0158
CCP4	:	7.0.044 (Gargrove)
Ideal geometry (proteins)	:	Engh & Huber (2001)
Ideal geometry (DNA, RNA)	:	Parkinson et al. (1996)
Validation Pipeline (wwPDB-VP)	:	2.36

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 2.80 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	141614	3569 (2.80-2.80)
Ramachandran outliers	138981	3498 (2.80-2.80)
Sidechain outliers	138945	3500 (2.80-2.80)
RSRZ outliers	127900	3078 (2.80-2.80)
RNA backbone	3102	1227 (3.10-2.50)

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 <=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	129	72% 26% •
1	B	129	76% 19% 5%
1	C	129	81% 17% •
2	R	20	35% 5% 30% 25% 40%
2	S	20	55% 15% 25% 15% 45%

2 Entry composition (i)

There are 3 unique types of molecules in this entry. The entry contains 3527 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 MS2 COAT PROTEIN.

Mol	Chain	Residues	Atoms					ZeroOcc	AltConf	Trace
			Total	C	N	O	S			
1	A	129	962	606	165	187	4	0	0	0
1	B	129	962	606	165	187	4	0	0	0
1	C	129	962	606	165	187	4	0	0	0

There are 6 discrepancies between the modelled and reference sequences:

Chain	Residue	Modelled	Actual	Comment	Reference
A	87	ALA	ASN	engineered mutation	UNP P03612
A	89	LYS	GLU	engineered mutation	UNP P03612
B	87	ALA	ASN	engineered mutation	UNP P03612
B	89	LYS	GLU	engineered mutation	UNP P03612
C	87	ALA	ASN	engineered mutation	UNP P03612
C	89	LYS	GLU	engineered mutation	UNP P03612

- Molecule 2 is a RNA chain called 5'-R(*AP*CP*AP*UP*GP*AP*GP*GP*AP*UP *UP*AP*CP*CP*CP*AP*UP*GP*U)-3'.

Mol	Chain	Residues	Atoms					ZeroOcc	AltConf	Trace
			Total	C	N	O	P			
2	R	12	254	115	47	81	11	9	0	0
2	S	11	231	105	42	74	10	0	0	0

- Molecule 3 is water.

Mol	Chain	Residues	Atoms		ZeroOcc	AltConf
			Total	O		
3	A	39	39	39	0	0

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Mol	Chain	Residues	Atoms		ZeroOcc	AltConf
			Total	O		
3	B	66	66	66	0	0
			Total	O		
3	C	48	48	48	0	0
			Total	O		
3	R	1	1	1	0	0
			Total	O		
3	S	2	2	2	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: MS2 COAT PROTEIN

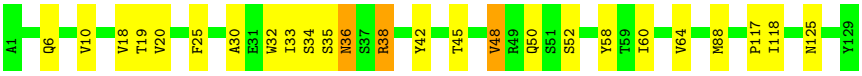
Chain A:

• Molecule 1: MS2 COAT PROTEIN

Chain B:

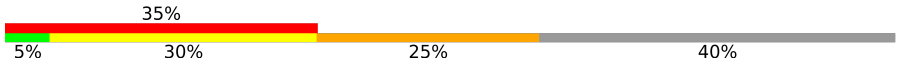
• Molecule 1: MS2 COAT PROTEIN

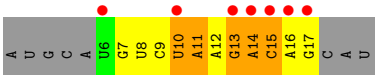
Chain C:



• Molecule 2: 5'-R(*AP*CP*AP*UP*GP*AP*GP*GP*AP*UP *UP*AP*CP*CP*CP*AP*UP*GP*U)-3'

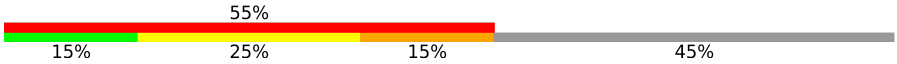
Chain R:

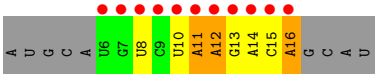




• Molecule 2: 5'-R(*AP*CP*AP*UP*GP*AP*GP*GP*AP*UP *UP*AP*CP*CP*CP*AP*UP*GP*U)-3'

Chain S:





4 Data and refinement statistics (i)

Property	Value	Source
Space group	P 1	Depositor
Cell constants a, b, c, α, β, γ	273.10Å 273.50Å 273.40Å 63.26° 63.11° 63.31°	Depositor
Resolution (Å)	29.94 – 2.80 30.05 – 2.59	Depositor EDS
% Data completeness (in resolution range)	23.5 (29.94-2.80) 19.6 (30.05-2.59)	Depositor EDS
R_{merge}	0.05	Depositor
R_{sym}	(Not available)	Depositor
$< I/\sigma(I) >$ [1]	3.76 (at 2.61Å)	Xtriage
Refinement program	CNS 1.1	Depositor
R, R_{free}	0.245 , 0.248 0.225 , (Not available)	Depositor DCC
R_{free} test set	No test flags present.	wwPDB-VP
Wilson B-factor (Å^2)	40.8	Xtriage
Anisotropy	0.152	Xtriage
Bulk solvent k_{sol}(e/Å^3), B_{sol}(Å^2)	0.32 , 42.0	EDS
L-test for twinning[2]	$< \|L\| > = 0.49$, $< L^2 > = 0.32$	Xtriage
Estimated twinning fraction	0.309 for l,h,k 0.309 for k,l,h 0.339 for -l,-k,-h 0.327 for -k,-h,-l 0.417 for -h,-l,-k	Xtriage
F_o,F_c correlation	0.90	EDS
Total number of atoms	3527	wwPDB-VP
Average B, all atoms (Å^2)	54.0	wwPDB-VP

Xtriage's analysis on translational NCS is as follows: *The largest off-origin peak in the Patterson function is 10.94% 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)

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	0.39	0/979	0.67	0/1332
1	B	0.39	0/979	0.69	0/1332
1	C	0.40	0/979	0.67	0/1332
2	R	0.33	0/284	0.76	1/441 (0.2%)
2	S	0.53	0/258	0.95	2/400 (0.5%)
All	All	0.40	0/3479	0.71	3/4837 (0.1%)

There are no bond length outliers.

All (3) bond angle outliers are listed below:

Mol	Chain	Res	Type	Atoms	Z	Observed(^{o})	Ideal(^{o})
2	S	12	A	O5'-C5'-C4'	-6.81	98.75	111.70
2	S	12	A	OP1-P-OP2	-5.76	110.97	119.60
2	R	16	A	N9-C1'-C2'	-5.72	105.71	112.00

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	962	0	970	28	0
1	B	962	0	970	25	0
1	C	962	0	970	15	0
2	R	254	0	131	8	0
2	S	231	0	120	13	0

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Mol	Chain	Non-H	H(model)	H(added)	Clashes	Symm-Clashes
3	A	39	0	0	0	0
3	B	66	0	0	2	0
3	C	48	0	0	3	0
3	R	1	0	0	0	0
3	S	2	0	0	0	0
All	All	3527	0	3161	80	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 13.

All (80) 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)
2:R:7:G:H1	2:R:15:C:H42	1.20	0.89
1:B:20:VAL:HG13	1:B:32:TRP:HB3	1.55	0.88
1:A:52:SER:HB3	1:A:55:ASN:HB2	1.60	0.84
1:A:57:LYS:HE3	1:A:89:LYS:HD2	1.64	0.78
2:R:8:U:H3	2:R:14:A:H61	1.30	0.78
2:R:7:G:H1	2:R:15:C:N4	1.89	0.71
2:S:13:G:H2'	2:S:14:A:O4'	1.92	0.69
1:A:129:TYR:H	1:B:3:ASN:HD21	1.40	0.68
2:R:9:C:O2'	2:R:10:U:H2'	1.95	0.67
1:C:20:VAL:HG22	1:C:32:TRP:HB3	1.77	0.66
1:A:97:THR:HG22	1:A:99:SER:H	1.61	0.65
1:A:86:LEU:HD22	1:B:108:MET:HG2	1.78	0.65
1:A:112:LEU:HD13	1:B:108:MET:HB3	1.80	0.64
2:R:8:U:H3	2:R:14:A:N6	1.94	0.64
1:A:57:LYS:CE	1:A:89:LYS:HD2	2.30	0.62
2:S:11:A:H2'	2:S:11:A:OP2	2.01	0.60
1:B:3:ASN:ND2	1:B:3:ASN:H	1.99	0.60
1:A:129:TYR:H	1:B:3:ASN:ND2	2.00	0.60
1:A:97:THR:HG22	1:A:99:SER:N	2.18	0.58
2:S:15:C:H2'	2:S:16:A:H5'	1.87	0.56
1:A:23:SER:HB3	1:A:33:ILE:HD12	1.87	0.55
1:B:10:VAL:HB	1:B:18:VAL:HB	1.88	0.54
1:A:79:VAL:HG22	1:A:80:ALA:H	1.72	0.54
1:A:111:LEU:HD11	1:A:118:ILE:HD12	1.90	0.54
1:A:10:VAL:HB	1:A:18:VAL:HB	1.90	0.53
1:A:52:SER:OG	1:A:53:ALA:N	2.40	0.53
1:A:105:VAL:O	1:A:109:GLN:HG3	2.09	0.53
2:S:15:C:N4	2:S:16:A:H62	2.07	0.53

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Atom-1	Atom-2	Interatomic distance (Å)	Clash overlap (Å)
2:S:11:A:OP2	2:S:11:A:C8	2.63	0.52
1:A:23:SER:CB	1:A:33:ILE:HD12	2.40	0.52
1:C:48:VAL:HG13	1:C:58:TYR:CD2	2.45	0.52
1:B:1:ALA:O	1:B:2:SER:HB2	2.10	0.51
2:S:8:U:H3	2:S:14:A:H61	1.58	0.51
2:S:10:U:H3'	2:S:11:A:H8	1.74	0.51
1:B:63:GLU:HG2	1:B:85:TYR:CD2	2.46	0.51
1:C:125:ASN:HA	3:C:2047:HOH:O	2.10	0.50
2:S:15:C:H42	2:S:16:A:H62	1.59	0.50
1:A:60:ILE:HD13	1:B:118:ILE:HG21	1.93	0.50
3:C:2033:HOH:O	2:S:10:U:H5'	2.11	0.50
2:S:11:A:OP2	2:S:11:A:H8	1.95	0.50
1:A:23:SER:HB3	1:A:33:ILE:CD1	2.42	0.49
1:A:49:ARG:HH11	1:A:51:SER:HA	1.76	0.49
2:R:12:A:H4'	2:R:13:G:C8	2.47	0.49
1:C:6:GLN:NE2	1:C:19:THR:HG21	2.27	0.49
1:B:83:ARG:HD2	3:B:2020:HOH:O	2.11	0.48
2:S:8:U:H6	2:S:8:U:O5'	1.95	0.48
2:S:12:A:H4'	2:S:13:G:C8	2.48	0.48
1:C:35:SER:O	1:C:36:ASN:HB2	2.13	0.48
2:R:10:U:H3'	2:R:11:A:H8	1.77	0.48
1:A:79:VAL:HG22	1:A:80:ALA:N	2.29	0.47
1:A:97:THR:CG2	1:A:98:ASN:N	2.77	0.47
2:S:8:U:H3	2:S:14:A:N6	2.12	0.47
1:C:38:ARG:NH2	3:C:2017:HOH:O	2.47	0.47
1:A:108:MET:HB3	1:B:112:LEU:HD13	1.98	0.46
1:B:1:ALA:O	1:B:2:SER:CB	2.63	0.46
1:B:58:TYR:HB2	1:B:90:LEU:HB3	1.98	0.45
1:A:97:THR:HB	1:A:100:ASP:OD2	2.16	0.45
1:B:103:LEU:C	1:B:103:LEU:HD23	2.38	0.44
2:R:13:G:H2'	2:R:14:A:O4'	2.19	0.43
1:A:1:ALA:O	1:A:2:SER:CB	2.67	0.43
1:B:30:ALA:O	1:B:45:THR:HA	2.19	0.43
1:B:6:GLN:NE2	1:B:19:THR:HG21	2.34	0.43
1:C:10:VAL:HB	1:C:18:VAL:HB	2.00	0.43
1:A:60:ILE:HB	1:A:88:MET:HG3	2.00	0.42
1:C:118:ILE:N	1:C:118:ILE:HD12	2.34	0.42
1:B:75:VAL:HG12	1:B:77:LEU:HD22	2.01	0.42
1:C:6:GLN:HE21	1:C:6:GLN:HB2	1.65	0.42
1:B:15:THR:O	1:B:15:THR:HG23	2.20	0.41
1:B:88:MET:HB3	1:B:88:MET:HE2	1.93	0.41

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Atom-1	Atom-2	Interatomic distance (Å)	Clash overlap (Å)
1:C:50:GLN:HG3	1:C:52:SER:O	2.20	0.41
1:C:60:ILE:HB	1:C:88:MET:HG3	2.01	0.41
1:B:114:ASP:HB2	3:B:2059:HOH:O	2.20	0.41
1:C:6:GLN:NE2	1:C:19:THR:CG2	2.84	0.41
1:A:108:MET:HG2	1:B:86:LEU:HD22	2.02	0.40
1:B:36:ASN:HB2	1:B:41:ALA:HB2	2.01	0.40
1:A:48:VAL:HG21	1:B:127:GLY:HA2	2.03	0.40
1:C:30:ALA:O	1:C:45:THR:HA	2.21	0.40
1:C:33:ILE:HG22	1:C:34:SER:O	2.20	0.40
1:A:88:MET:HB3	1:B:88:MET:HG2	2.03	0.40
1:C:42:TYR:CE2	1:C:64:VAL:HG13	2.57	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	127/129 (98%)	119 (94%)	5 (4%)	3 (2%)	6 20
1	B	127/129 (98%)	120 (94%)	5 (4%)	2 (2%)	9 31
1	C	127/129 (98%)	120 (94%)	5 (4%)	2 (2%)	9 31
All	All	381/387 (98%)	359 (94%)	15 (4%)	7 (2%)	8 28

All (7) Ramachandran outliers are listed below:

Mol	Chain	Res	Type
1	A	2	SER
1	B	2	SER
1	B	14	GLY
1	A	14	GLY
1	C	36	ASN
1	A	13	GLY

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Mol	Chain	Res	Type
1	C	117	PRO

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	105/105 (100%)	99 (94%)	6 (6%)	20	50
1	B	105/105 (100%)	99 (94%)	6 (6%)	20	50
1	C	105/105 (100%)	102 (97%)	3 (3%)	42	76
All	All	315/315 (100%)	300 (95%)	15 (5%)	25	58

All (15) residues with a non-rotameric sidechain are listed below:

Mol	Chain	Res	Type
1	A	4	PHE
1	A	8	VAL
1	A	19	THR
1	A	25	PHE
1	A	33	ILE
1	A	48	VAL
1	B	3	ASN
1	B	19	THR
1	B	20	VAL
1	B	48	VAL
1	B	77	LEU
1	B	114	ASP
1	C	25	PHE
1	C	38	ARG
1	C	48	VAL

Sometimes sidechains can be flipped to improve hydrogen bonding and reduce clashes. All (6) such sidechains are listed below:

Mol	Chain	Res	Type
1	A	55	ASN

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Mol	Chain	Res	Type
1	B	3	ASN
1	B	6	GLN
1	B	36	ASN
1	C	6	GLN
1	C	27	ASN

5.3.3 RNA (i)

Mol	Chain	Analysed	Backbone Outliers	Pucker Outliers
2	R	11/20 (55%)	5 (45%)	1 (9%)
2	S	10/20 (50%)	2 (20%)	0
All	All	21/40 (52%)	7 (33%)	1 (4%)

All (7) RNA backbone outliers are listed below:

Mol	Chain	Res	Type
2	R	11	A
2	R	13	G
2	R	14	A
2	R	15	C
2	R	17	G
2	S	11	A
2	S	16	A

All (1) RNA pucker outliers are listed below:

Mol	Chain	Res	Type
2	R	10	U

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)

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 (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	129/129 (100%)	-0.89	0	100	100	35, 46, 65, 85	0
1	B	129/129 (100%)	-0.88	0	100	100	34, 44, 66, 85	0
1	C	129/129 (100%)	-0.94	0	100	100	36, 46, 66, 94	0
2	R	12/20 (60%)	3.24	7 (58%)	0	0	64, 97, 120, 122	12 (100%)
2	S	11/20 (55%)	14.72	11 (100%)	0	0	75, 99, 113, 116	11 (100%)
All	All	410/427 (96%)	-0.36	18 (4%)	34	24	34, 46, 85, 122	23 (5%)

All (18) RSRZ outliers are listed below:

Mol	Chain	Res	Type	RSRZ
2	S	10	U	21.4
2	S	16	A	21.2
2	S	15	C	19.2
2	S	7	G	17.7
2	S	14	A	16.4
2	S	13	G	14.7
2	S	11	A	13.2
2	S	9	C	12.2
2	S	8	U	11.1
2	S	6	U	10.7
2	R	17	G	6.7
2	R	6	U	6.4
2	R	16	A	4.6
2	R	14	A	4.5
2	R	15	C	4.4
2	S	12	A	4.1
2	R	13	G	3.2
2	R	10	U	2.7

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)

There are no ligands in this entry.

6.5 Other polymers (i)

There are no such residues in this entry.