



Full wwPDB X-ray Structure Validation Report ⓘ

Mar 5, 2026 – 03:29 PM UTC

PDB ID : 1X9K / pdb_00001x9k
Title : An all-RNA Hairpin Ribozyme with mutation U39C
Authors : Alam, S.; Grum-Tokars, V.; Krucinska, J.; Kundracik, M.L.; Wedekind, J.E.
Deposited on : 2004-08-21
Resolution : 3.17 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

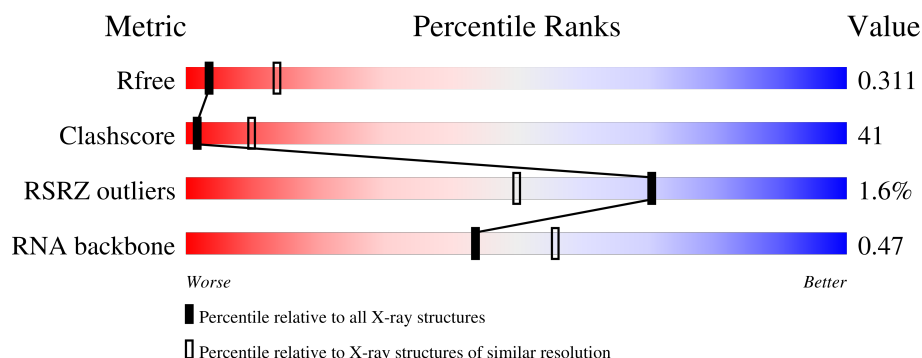
1 Overall quality at a glance

The following experimental techniques were used to determine the structure:

X-RAY DIFFRACTION

The reported resolution of this entry is 3.17 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}	180053	2001 (3.20-3.16)
Clashscore	190562	2119 (3.20-3.16)
RSRZ outliers	180081	2001 (3.20-3.16)
RNA backbone	3983	1138 (3.46-2.90)

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	13	23% 46% 8% 23%
2	B	13	8% 31% 62% 8%
3	C	17	12% 76% 12%
4	D	19	21% 37% 21% 21%

2 Entry composition [i](#)

There are 4 unique types of molecules in this entry. The entry contains 1313 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 RNA chain called 5'-R(*UP*CP*GP*CP*AP*GP*UP*CP*CP*UP*AP*UP*U)-3'.

Mol	Chain	Residues	Atoms					ZeroOcc	AltConf	Trace
1	A	13	Total	C	N	O	P	0	0	0
			267	121	42	92	12			

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

Mol	Chain	Residues	Atoms					ZeroOcc	AltConf	Trace
2	B	13	Total	C	N	O	P	0	0	0
			283	128	60	83	12			

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

Mol	Chain	Residues	Atoms					ZeroOcc	AltConf	Trace
3	C	17	Total	C	N	O	P	0	0	0
			368	166	77	109	16			

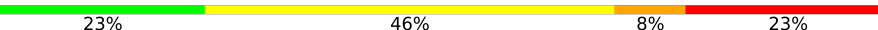
- Molecule 4 is a RNA chain called 5'-R(*UP*CP*GP*UP*GP*GP*UP*AP*CP*AP*UP*UP*AP*CP*CP*UP*GP*CP*C)-3'.

Mol	Chain	Residues	Atoms					ZeroOcc	AltConf	Trace
4	D	19	Total	C	N	O	P	0	0	0
			395	178	65	134	18			

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

Chain A: 

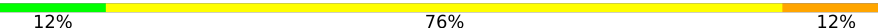


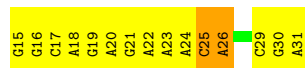
- Molecule 2: 5'-R(*AP*AP*UP*AP*GP*AP*GP*AP*AP*GP*CP*GP*A)-3'

Chain B: 

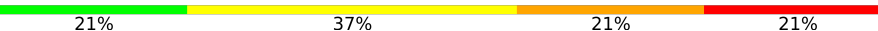


- Molecule 3: 5'-R(*GP*GP*CP*AP*GP*AP*GP*AP*AP*AP*CP*AP*CP*AP*CP*GP*A)-3',

Chain C: 



- Molecule 4: 5'-R(*UP*CP*GP*UP*GP*GP*UP*AP*CP*AP*UP*UP*AP*CP*CP*UP*GP*CP*C)-3'

Chain D: 



4 Data and refinement statistics

Property	Value	Source
Space group	P 61 2 2	Depositor
Cell constants a, b, c, α , β , γ	94.46Å 94.46Å 129.12Å 90.00° 90.00° 120.00°	Depositor
Resolution (Å)	24.63 – 3.17 24.63 – 3.17	Depositor EDS
% Data completeness (in resolution range)	99.5 (24.63-3.17) 99.2 (24.63-3.17)	Depositor EDS
R_{merge}	(Not available)	Depositor
R_{sym}	0.06	Depositor
$\langle I/\sigma(I) \rangle$ ¹	3.27 (at 3.11Å)	Xtriage
Refinement program	CNS 1.1	Depositor
R, R_{free}	0.236 , 0.252 0.235 , 0.311	Depositor DCC
R_{free} test set	687 reflections (10.60%)	wwPDB-VP
Wilson B-factor (Å ²)	116.4	Xtriage
Anisotropy	0.144	Xtriage
Bulk solvent k_{sol} (e/Å ³), B_{sol} (Å ²)	0.17 , 161.3	EDS
L-test for twinning ²	$\langle L \rangle = 0.45$, $\langle L^2 \rangle = 0.28$	Xtriage
Estimated twinning fraction	No twinning to report.	Xtriage
F_o, F_c correlation	0.96	EDS
Total number of atoms	1313	wwPDB-VP
Average B, all atoms (Å ²)	160.0	wwPDB-VP

Xtriage's analysis on translational NCS is as follows: *The largest off-origin peak in the Patterson function is 7.05% 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	0/296	1.07	2/458 (0.4%)
2	B	0.48	0/319	0.84	0/497
3	C	0.59	0/414	0.92	2/645 (0.3%)
4	D	0.63	0/439	1.20	7/681 (1.0%)
All	All	0.58	0/1468	1.02	11/2281 (0.5%)

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	2
4	D	0	1
All	All	0	3

There are no bond length outliers.

All (11) bond angle outliers are listed below:

Mol	Chain	Res	Type	Atoms	Z	Observed(°)	Ideal(°)
1	A	7	G	N9-C1'-C2'	7.69	125.53	114.00
3	C	26	A	C3'-C2'-O2'	7.11	121.37	110.70
4	D	38	A	N9-C1'-C2'	6.97	124.46	114.00
4	D	42	U	C2'-C3'-O3'	-6.29	100.06	109.50
4	D	41	U	C2'-C3'-O3'	5.96	118.44	109.50
1	A	7	G	O4'-C1'-C2'	5.84	111.64	105.80
4	D	38	A	C2'-C3'-O3'	-5.80	100.80	109.50
4	D	41	U	N1-C1'-C2'	5.39	122.08	114.00
4	D	36	G	N9-C1'-C2'	5.23	121.84	114.00
4	D	41	U	C4'-C3'-O3'	-5.22	101.56	109.40
3	C	25	C	O4'-C4'-C3'	-5.02	98.98	104.00

There are no chirality outliers.

All (3) planarity outliers are listed below:

Mol	Chain	Res	Type	Group
1	A	6	A	Sidechain
1	A	8	U	Sidechain
4	D	31	U	Sidechain

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	267	0	140	28	0
2	B	283	0	144	21	0
3	C	368	0	189	23	0
4	D	395	0	205	24	0
All	All	1313	0	678	79	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 41.

All (79) 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)
4:D:38:A:OP2	4:D:39:C:H2'	1.72	0.90
4:D:42:U:H3'	4:D:42:U:OP2	1.78	0.83
4:D:41:U:O2'	4:D:42:U:OP2	1.97	0.83
2:B:13:G:H2'	2:B:14:A:H4'	1.63	0.80
4:D:31:U:H2'	4:D:32:C:H6	1.46	0.79
4:D:38:A:H5''	4:D:39:C:H3'	1.69	0.72
1:A:3:C:H2'	1:A:4:G:H5'	1.73	0.71
4:D:33:G:H2'	4:D:34:U:H6	1.56	0.70
3:C:26:A:H61	4:D:36:G:H1	1.38	0.69
4:D:31:U:H2'	4:D:32:C:C6	2.29	0.68
1:A:3:C:C2'	1:A:4:G:H5''	2.26	0.66
3:C:15:G:H2'	3:C:16:G:C8	2.32	0.65
2:B:13:G:C2'	2:B:14:A:H4'	2.27	0.65
1:A:3:C:H2'	1:A:4:G:C5'	2.28	0.63
1:A:4:G:C2	2:B:13:G:N3	2.67	0.63

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Atom-1	Atom-2	Interatomic distance (Å)	Clash overlap (Å)
1:A:3:C:O2'	1:A:4:G:H5''	1.98	0.63
3:C:24:A:H2'	3:C:25:C:O4'	2.00	0.60
2:B:4:U:H2'	2:B:5:A:H8	1.66	0.60
1:A:3:C:C2'	1:A:4:G:C5'	2.80	0.60
1:A:4:G:N2	2:B:13:G:C4	2.69	0.60
1:A:4:G:H21	2:B:13:G:H1'	1.67	0.59
4:D:33:G:H2'	4:D:34:U:C6	2.37	0.59
4:D:32:C:H2'	4:D:33:G:C8	2.37	0.59
1:A:4:G:N2	2:B:13:G:H1'	2.17	0.59
3:C:17:C:H2'	3:C:18:A:C8	2.39	0.58
3:C:17:C:H2'	3:C:18:A:H8	1.68	0.58
4:D:32:C:H2'	4:D:33:G:H8	1.69	0.57
1:A:8:U:H2'	1:A:9:C:C5'	2.37	0.55
3:C:15:G:H2'	3:C:16:G:H8	1.69	0.55
1:A:4:G:H5'	1:A:4:G:C8	2.42	0.55
4:D:47:G:O2'	4:D:48:C:H5'	2.07	0.54
1:A:4:G:H5'	1:A:4:G:H8	1.72	0.53
2:B:9:A:C2	2:B:10:A:C4	2.96	0.53
4:D:32:C:O2	4:D:33:G:C8	2.61	0.53
2:B:11:G:H2'	2:B:12:C:C6	2.44	0.52
3:C:25:C:O2	3:C:25:C:H2'	2.09	0.52
2:B:13:G:O2'	4:D:43:A:H5'	2.10	0.51
4:D:38:A:H5'	4:D:40:A:O4'	2.11	0.51
4:D:42:U:HO2'	4:D:43:A:H8	1.54	0.51
1:A:6:A:HO2'	1:A:7:G:P	2.33	0.50
1:A:11:U:H2'	1:A:12:A:C8	2.45	0.50
1:A:8:U:C5	1:A:9:C:C4	3.00	0.50
4:D:33:G:C4	4:D:34:U:C5	3.00	0.50
3:C:16:G:C6	3:C:17:C:C4	3.00	0.49
2:B:12:C:C2'	2:B:13:G:H5'	2.43	0.49
2:B:10:A:N6	2:B:11:G:N1	2.61	0.48
1:A:4:G:N2	2:B:13:G:N3	2.61	0.48
1:A:9:C:H6	1:A:9:C:O5'	1.97	0.48
3:C:19:G:C2	4:D:46:U:C2	3.02	0.48
1:A:9:C:H42	2:B:8:G:N2	2.12	0.48
4:D:42:U:O2'	4:D:43:A:C8	2.67	0.47
3:C:17:C:H6	3:C:17:C:O5'	1.98	0.47
1:A:6:A:O2'	1:A:7:G:OP2	2.30	0.46
1:A:5:C:O2'	4:D:41:U:H4'	2.15	0.46
2:B:4:U:H2'	2:B:5:A:C8	2.48	0.46
3:C:19:G:H2'	3:C:20:A:O4'	2.15	0.46

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Atom-1	Atom-2	Interatomic distance (Å)	Clash overlap (Å)
1:A:6:A:C2	2:B:8:G:C4	3.04	0.46
1:A:10:C:O2'	1:A:11:U:H5'	2.15	0.46
3:C:18:A:H2'	3:C:19:G:H8	1.80	0.46
1:A:8:U:H2'	1:A:9:C:O5'	2.16	0.46
1:A:11:U:H3	2:B:5:A:H61	1.63	0.45
3:C:30:G:H2'	3:C:31:A:H8	1.81	0.45
1:A:4:G:N2	2:B:13:G:C1'	2.79	0.45
3:C:25:C:O2	3:C:25:C:C2'	2.62	0.45
1:A:4:G:C2	2:B:13:G:C2	3.05	0.45
3:C:18:A:O2'	3:C:19:G:H5'	2.17	0.45
3:C:29:C:C2	3:C:30:G:C8	3.05	0.44
1:A:8:U:O4	2:B:9:A:C5	2.70	0.44
4:D:31:U:C2	4:D:32:C:C5	3.05	0.44
3:C:26:A:N6	4:D:36:G:H1	2.12	0.44
3:C:21:G:H8	3:C:21:G:O5'	2.00	0.44
4:D:37:U:H5''	4:D:39:C:C5	2.52	0.44
3:C:30:G:C6	3:C:31:A:C5	3.06	0.43
3:C:30:G:C4	3:C:31:A:C8	3.07	0.43
4:D:36:G:HO2'	4:D:37:U:H6	1.62	0.43
1:A:7:G:N3	3:C:26:A:C2	2.87	0.42
3:C:16:G:C2	3:C:17:C:C2	3.08	0.42
2:B:4:U:O2'	2:B:5:A:H5'	2.21	0.41
3:C:22:A:C2	3:C:23:A:H1'	2.55	0.41

There are no symmetry-related clashes.

5.3 Torsion angles [i](#)

5.3.1 Protein backbone [i](#)

There are no protein molecules in this entry.

5.3.2 Protein sidechains [i](#)

There are no protein molecules in this entry.

5.3.3 RNA [i](#)

Mol	Chain	Analysed	Backbone Outliers	Pucker Outliers
1	A	12/13 (92%)	4 (33%)	2 (16%)
2	B	12/13 (92%)	1 (8%)	0
3	C	16/17 (94%)	0	0
4	D	18/19 (94%)	7 (38%)	5 (27%)
All	All	58/62 (93%)	12 (20%)	7 (12%)

All (12) RNA backbone outliers are listed below:

Mol	Chain	Res	Type
1	A	4	G
1	A	6	A
1	A	7	G
1	A	8	U
2	B	14	A
4	D	36	G
4	D	37	U
4	D	38	A
4	D	39	C
4	D	40	A
4	D	41	U
4	D	42	U

All (7) RNA pucker outliers are listed below:

Mol	Chain	Res	Type
1	A	6	A
1	A	7	G
4	D	36	G
4	D	37	U
4	D	38	A
4	D	39	C
4	D	41	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 oligosaccharides in this entry.

5.6 Ligand geometry

There are no ligands in this entry.

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 [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	13/13 (100%)	0.22	0 100 100	112, 151, 256, 264	0
2	B	13/13 (100%)	0.07	1 (7%) 19 11	129, 158, 229, 232	0
3	C	17/17 (100%)	-0.06	0 100 100	120, 143, 165, 167	0
4	D	19/19 (100%)	0.05	0 100 100	132, 147, 174, 178	0
All	All	62/62 (100%)	0.06	1 (1%) 70 50	112, 151, 229, 264	0

All (1) RSRZ outliers are listed below:

Mol	Chain	Res	Type	RSRZ
2	B	14	A	6.3

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.