



Full wwPDB X-ray Structure Validation Report ⓘ

Mar 23, 2026 – 11:47 PM UTC

PDB ID : 9FN2 / pdb_00009fn2
Title : Crystal structure of the alkyltransferase ribozyme SAMURI co-crystallized with SAM
Authors : Chen, H.-A.; Okuda, T.; Lenz, A.-K.; Scheitl, C.P.M.; Schindelin, H.; Hoebartner, C.
Deposited on : 2024-06-07
Resolution : 2.90 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	:	FAILED
Mogul	:	2022.3.0, CSD as543be (2022)
Xtriage (Phenix)	:	2.0
EDS	:	3.0
Buster-report	:	wwPDB partial adaption of 1.1.7 (2018)
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

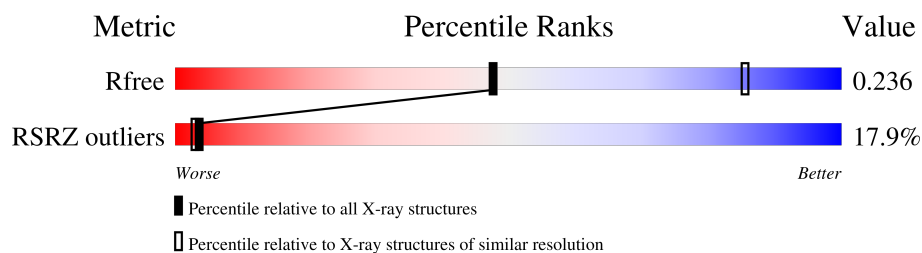
1 Overall quality at a glance

The following experimental techniques were used to determine the structure:

X-RAY DIFFRACTION

The reported resolution of this entry is 2.90 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	2481 (2.90-2.90)
RSRZ outliers	180081	2481 (2.90-2.90)

MolProbity failed to run properly - the sequence quality summary graphics cannot be shown.

2 Entry composition [i](#)

There are 4 unique types of molecules in this entry. The entry contains 3893 atoms, of which 1300 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.

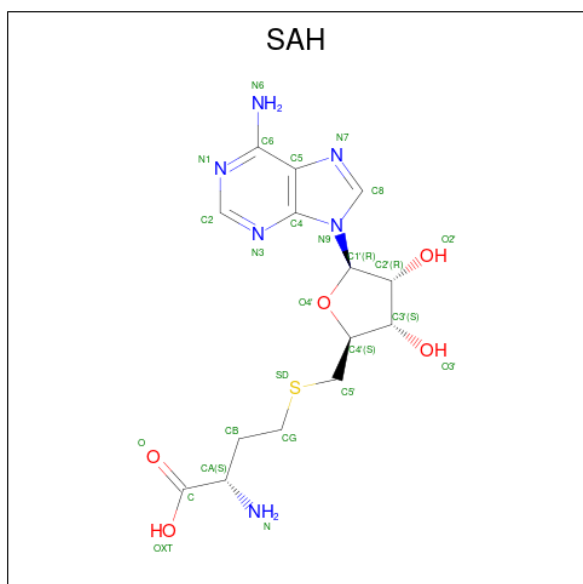
- Molecule 1 is a RNA chain called SAMURI-SAM.

Mol	Chain	Residues	Atoms						ZeroOcc	AltConf	Trace
1	A	58	Total	C	H	N	O	P	0	0	0
			1878	554	631	225	409	59			
1	B	58	Total	C	H	N	O	P	0	0	0
			1878	554	631	225	409	59			

- Molecule 2 is MAGNESIUM ION (CCD ID: MG) (formula: Mg).

Mol	Chain	Residues	Atoms		ZeroOcc	AltConf
2	A	4	Total	Mg	0	0
			4	4		
2	B	3	Total	Mg	0	0
			3	3		

- Molecule 3 is S-ADENOSYL-L-HOMOCYSTEINE (CCD ID: SAH) (formula: C₁₄H₂₀N₆O₅S).



Mol	Chain	Residues	Atoms						ZeroOcc	AltConf
3	A	1	Total	C	H	N	O	S	0	0
			45	14	19	6	5	1		
3	B	1	Total	C	H	N	O	S	0	0
			45	14	19	6	5	1		

- Molecule 4 is water.

Mol	Chain	Residues	Atoms		ZeroOcc	AltConf
4	A	25	Total	O	0	0
			25	25		
4	B	15	Total	O	0	0
			15	15		

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3 Data and refinement statistics

Property	Value	Source
Space group	P 42	Depositor
Cell constants a, b, c, α , β , γ	75.44Å 75.44Å 73.15Å 90.00° 90.00° 90.00°	Depositor
Resolution (Å)	33.74 – 2.90 33.74 – 2.90	Depositor EDS
% Data completeness (in resolution range)	99.9 (33.74-2.90) 99.9 (33.74-2.90)	Depositor EDS
R_{merge}	0.05	Depositor
R_{sym}	(Not available)	Depositor
$\langle I/\sigma(I) \rangle$ ¹	1.39 (at 2.81Å)	Xtriage
Refinement program	PHENIX 1.20.1_4487	Depositor
R, R_{free}	0.204 , 0.230 0.209 , 0.236	Depositor DCC
R_{free} test set	532 reflections (5.21%)	wwPDB-VP
Wilson B-factor (Å ²)	28.8	Xtriage
Anisotropy	0.027	Xtriage
Bulk solvent k_{sol} (e/Å ³), B_{sol} (Å ²)	0.37 , 56.4	EDS
L-test for twinning ²	$\langle L \rangle = 0.50$, $\langle L^2 \rangle = 0.33$	Xtriage
Estimated twinning fraction	0.016 for -h,-l,-k 0.000 for -h,l,k 0.000 for l,-k,h 0.022 for -l,-k,-h 0.042 for h,-k,-l	Xtriage
F_o, F_c correlation	0.90	EDS
Total number of atoms	3893	wwPDB-VP
Average B, all atoms (Å ²)	55.0	wwPDB-VP

Xtriage's analysis on translational NCS is as follows: *The largest off-origin peak in the Patterson function is 4.92% 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.

4 Model quality [i](#)

4.1 Standard geometry [i](#)

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4.2 Too-close contacts [i](#)

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4.3 Torsion angles [i](#)

4.3.1 Protein backbone [i](#)

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4.3.2 Protein sidechains [i](#)

MolProbity failed to run properly - this section is therefore empty.

4.3.3 RNA [i](#)

MolProbity failed to run properly - this section is therefore empty.

4.4 Non-standard residues in protein, DNA, RNA chains [i](#)

4 non-standard protein/DNA/RNA residues 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	$\# Z > 2$
1	A1IEA	B	52	1,2	20,25,26	1.54	3 (15%)	27,37,40	0.96	2 (7%)
1	GDP	A	1	1	29,30,30	0.50	0	45,47,47	0.59	0
1	GDP	B	1	1	29,30,30	0.49	0	45,47,47	0.59	0
1	A1IEA	A	52	1	20,25,26	1.53	3 (15%)	27,37,40	0.95	2 (7%)

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
1	A1IEA	B	52	1,2	-	3/7/34/35	0/3/3/3
1	GDP	A	1	1	-	4/16/32/32	0/3/3/3
1	GDP	B	1	1	-	0/16/32/32	0/3/3/3
1	A1IEA	A	52	1	-	3/7/34/35	0/3/3/3

All (6) bond length outliers are listed below:

Mol	Chain	Res	Type	Atoms	Z	Observed(Å)	Ideal(Å)
1	B	52	A1IEA	C6-N6	5.20	1.47	1.34
1	A	52	A1IEA	C6-N6	5.18	1.47	1.34
1	B	52	A1IEA	C8-N9	-3.07	1.32	1.37
1	A	52	A1IEA	C8-N9	-3.06	1.32	1.37
1	B	52	A1IEA	C5-N7	-2.43	1.34	1.39
1	A	52	A1IEA	C5-N7	-2.40	1.34	1.39

All (4) bond angle outliers are listed below:

Mol	Chain	Res	Type	Atoms	Z	Observed(°)	Ideal(°)
1	A	52	A1IEA	N9-C8-N7	-2.66	110.17	113.94
1	B	52	A1IEA	N9-C8-N7	-2.61	110.23	113.94
1	A	52	A1IEA	C5-N7-C8	2.43	107.27	103.45
1	B	52	A1IEA	C5-N7-C8	2.40	107.23	103.45

There are no chirality outliers.

All (10) torsion outliers are listed below:

Mol	Chain	Res	Type	Atoms
1	A	1	GDP	C5'-O5'-PA-O3A
1	A	1	GDP	C5'-O5'-PA-O2A
1	A	52	A1IEA	C2'-C1'-N9-C8
1	B	52	A1IEA	C2'-C1'-N9-C4
1	B	52	A1IEA	C2'-C1'-N9-C8
1	A	1	GDP	O4'-C4'-C5'-O5'
1	A	52	A1IEA	C2'-C1'-N9-C4
1	A	1	GDP	C3'-C4'-C5'-O5'
1	B	52	A1IEA	O4'-C4'-C5'-O5'
1	A	52	A1IEA	O4'-C4'-C5'-O5'

There are no ring outliers.

No monomer is involved in short contacts.

4.5 Carbohydrates [i](#)

There are no oligosaccharides in this entry.

4.6 Ligand geometry [i](#)

Of 9 ligands modelled in this entry, 7 are monoatomic - leaving 2 for Mogul analysis.

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	$\# Z > 2$
3	SAH	A	204	-	27,28,28	1.07	4 (14%)	36,40,40	2.02	9 (25%)
3	SAH	B	203	-	27,28,28	1.06	4 (14%)	36,40,40	1.99	9 (25%)

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
3	SAH	A	204	-	-	2/15/31/31	0/3/3/3
3	SAH	B	203	-	-	0/15/31/31	0/3/3/3

All (8) bond length outliers are listed below:

Mol	Chain	Res	Type	Atoms	Z	Observed(Å)	Ideal(Å)
3	B	203	SAH	C2-N3	2.51	1.38	1.33
3	A	204	SAH	C2-N3	2.48	1.38	1.33
3	B	203	SAH	C2-N1	2.43	1.38	1.33
3	A	204	SAH	C2-N1	2.37	1.38	1.33
3	A	204	SAH	OXT-C	-2.19	1.23	1.30
3	B	203	SAH	OXT-C	-2.18	1.23	1.30

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Mol	Chain	Res	Type	Atoms	Z	Observed(Å)	Ideal(Å)
3	B	203	SAH	C8-N7	2.15	1.35	1.31
3	A	204	SAH	C8-N7	2.11	1.35	1.31

All (18) bond angle outliers are listed below:

Mol	Chain	Res	Type	Atoms	Z	Observed(°)	Ideal(°)
3	A	204	SAH	N3-C2-N1	-5.42	120.37	128.58
3	B	203	SAH	N3-C2-N1	-5.40	120.41	128.58
3	A	204	SAH	C5-C4-N3	-4.55	120.45	126.72
3	B	203	SAH	C5-C4-N3	-4.46	120.57	126.72
3	B	203	SAH	N9-C8-N7	-3.94	108.35	113.94
3	A	204	SAH	N9-C8-N7	-3.92	108.38	113.94
3	A	204	SAH	C5'-SD-CG	-3.61	91.54	102.26
3	B	203	SAH	C5-N7-C8	3.47	108.90	103.45
3	A	204	SAH	C2-N3-C4	3.44	120.22	111.83
3	A	204	SAH	C5-N7-C8	3.43	108.85	103.45
3	B	203	SAH	C2-N3-C4	3.42	120.19	111.83
3	B	203	SAH	C5'-SD-CG	-3.19	92.80	102.26
3	A	204	SAH	N3-C4-N9	2.84	132.00	127.17
3	B	203	SAH	N3-C4-N9	2.70	131.76	127.17
3	B	203	SAH	C4-C5-N7	-2.66	107.54	110.58
3	B	203	SAH	OXT-C-O	-2.66	118.06	124.08
3	A	204	SAH	OXT-C-O	-2.57	118.25	124.08
3	A	204	SAH	C4-C5-N7	-2.52	107.70	110.58

There are no chirality outliers.

All (2) torsion outliers are listed below:

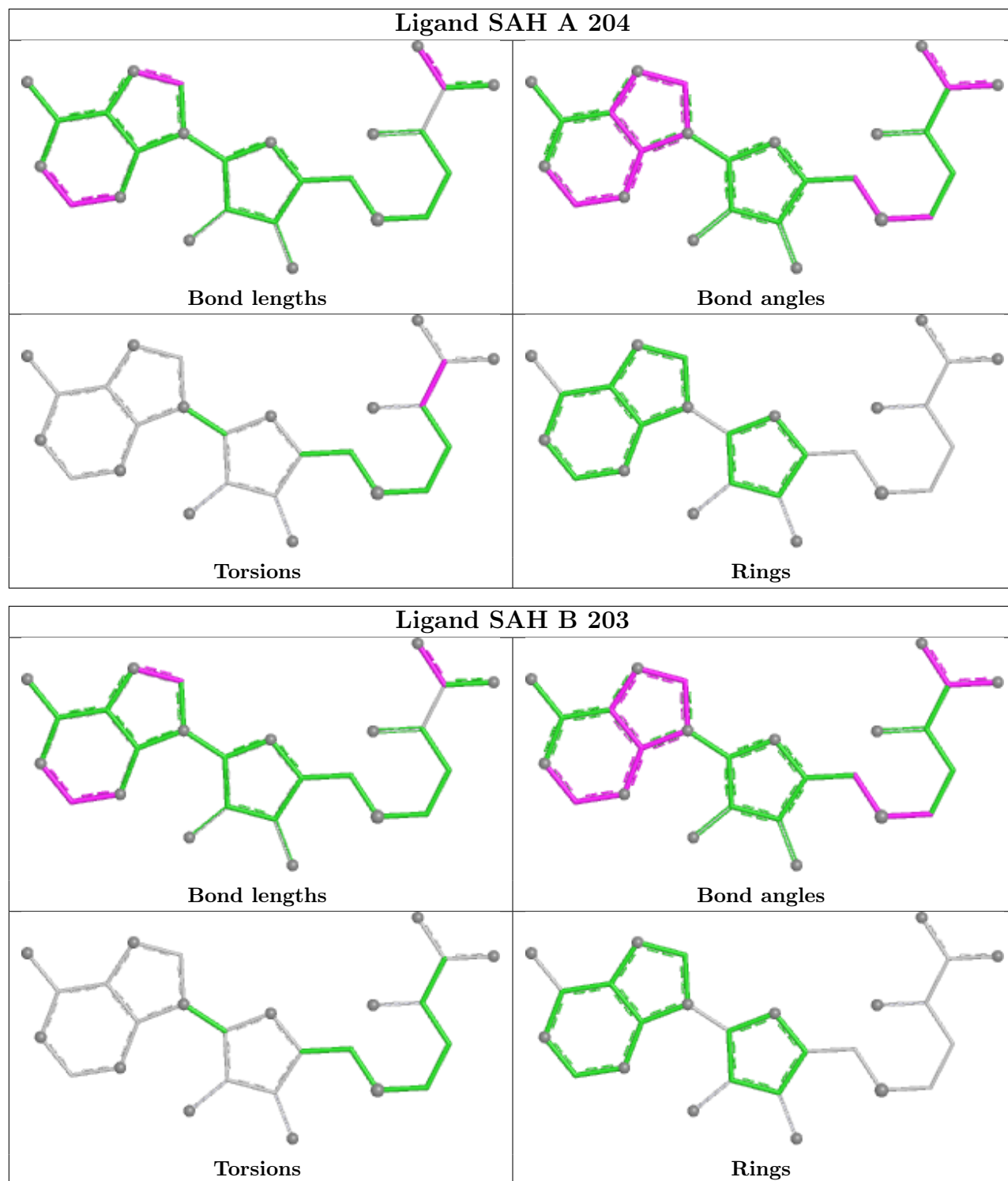
Mol	Chain	Res	Type	Atoms
3	A	204	SAH	OXT-C-CA-N
3	A	204	SAH	O-C-CA-N

There are no ring outliers.

No monomer is involved in short contacts.

The following is a two-dimensional graphical depiction of Mogul quality analysis of bond lengths, bond angles, torsion angles, and ring geometry for all instances of the Ligand of Interest. In addition, ligands with molecular weight > 250 and outliers as shown on the validation Tables will also be included. For torsion angles, if less than 5% of the Mogul distribution of torsion angles is within 10 degrees of the torsion angle in question, then that torsion angle is considered an outlier. Any bond that is central to one or more torsion angles identified as an outlier by Mogul will be highlighted in the graph. For rings, the root-mean-square deviation (RMSD) between the ring

in question and similar rings identified by Mogul is calculated over all ring torsion angles. If the average RMSD is greater than 60 degrees and the minimal RMSD between the ring in question and any Mogul-identified rings is also greater than 60 degrees, then that ring is considered an outlier. The outliers are highlighted in purple. The color gray indicates Mogul did not find sufficient equivalents in the CSD to analyse the geometry.



4.7 Other polymers [i](#)

There are no such residues in this entry.

4.8 Polymer linkage issues [i](#)

There are no chain breaks in this entry.

5 Fit of model and data

5.1 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	56/58 (96%)	1.17	9 (16%) 4 4	24, 43, 137, 173	0
1	B	56/58 (96%)	0.71	11 (19%) 3 2	18, 34, 139, 169	0
All	All	112/116 (96%)	0.94	20 (17%) 3 3	18, 36, 139, 173	0

All (20) RSRZ outliers are listed below:

Mol	Chain	Res	Type	RSRZ
1	A	25	C	6.3
1	B	2	G	5.3
1	B	57	C	4.7
1	A	2	G	4.5
1	B	58	C	4.1
1	B	56	U	3.8
1	B	4	G	3.7
1	B	55	C	3.6
1	B	7	A	3.4
1	A	6	C	3.3
1	B	6	C	3.3
1	A	24	G	3.2
1	A	22	U	3.1
1	B	5	U	3.0
1	A	3	A	3.0
1	A	5	U	2.7
1	B	3	A	2.7
1	A	7	A	2.5
1	A	4	G	2.5
1	B	8	U	2.4

5.2 Non-standard residues in protein, DNA, RNA chains [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
1	GDP	B	1	28/28	0.57	0.25	111,132,164,178	0
1	GDP	A	1	28/28	0.62	0.21	104,131,163,173	0
1	A1IEA	A	52	23/24	0.95	0.10	20,24,39,45	0
1	A1IEA	B	52	23/24	0.95	0.10	16,25,43,52	0

5.3 Carbohydrates [i](#)

There are no oligosaccharides in this entry.

5.4 Ligands [i](#)

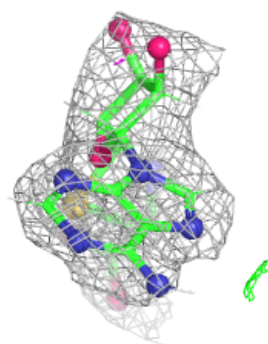
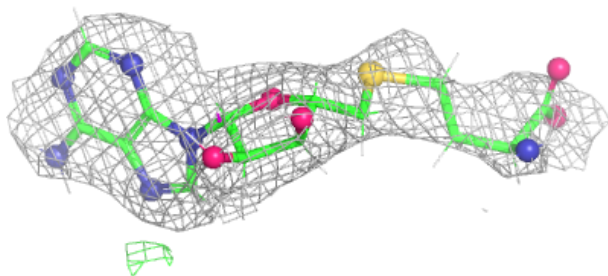
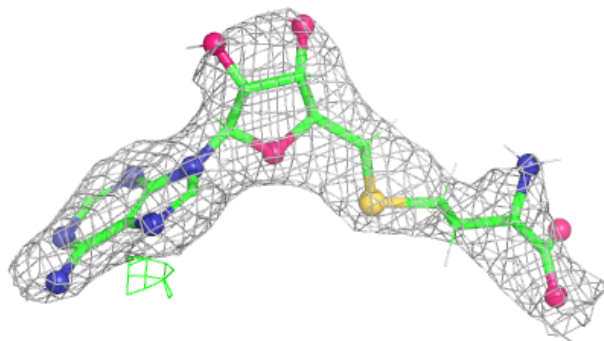
In the following table, the Atoms column lists the number of modelled atoms in the group and the number defined in the chemical component dictionary. The B-factors column lists the minimum, median, 95th percentile and maximum values of B factors of atoms in the group. The column labelled 'Q< 0.9' lists the number of atoms with occupancy less than 0.9.

Mol	Type	Chain	Res	Atoms	RSCC	RSR	B-factors(Å ²)	Q<0.9
2	MG	A	202	1/1	0.87	0.08	35,35,35,35	0
3	SAH	B	203	26/26	0.91	0.12	17,37,71,82	0
3	SAH	A	204	26/26	0.92	0.12	21,39,94,103	0
2	MG	B	201	1/1	0.93	0.09	33,33,33,33	0
2	MG	A	203	1/1	0.94	0.08	79,79,79,79	0
2	MG	A	201	1/1	0.96	0.09	67,67,67,67	0
2	MG	B	204	1/1	0.96	0.07	31,31,31,31	0
2	MG	B	202	1/1	0.97	0.07	42,42,42,42	0
2	MG	A	205	1/1	0.97	0.06	20,20,20,20	0

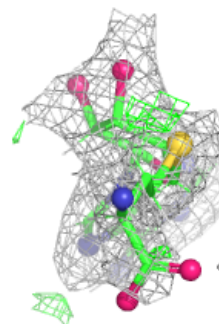
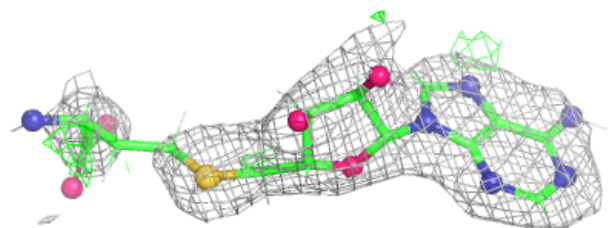
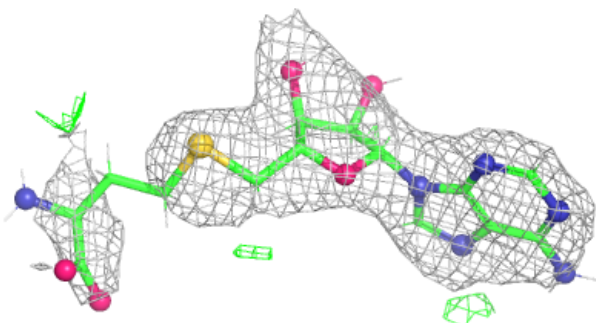
The following is a graphical depiction of the model fit to experimental electron density of all instances of the Ligand of Interest. In addition, ligands with molecular weight > 250 and outliers as shown on the geometry validation Tables will also be included. Each fit is shown from different orientation to approximate a three-dimensional view.

Electron density around SAH B 203:

$2mF_o-DF_c$ (at 0.7 rmsd) in gray
 mF_o-DF_c (at 3 rmsd) in purple (negative)
and green (positive)

**Electron density around SAH A 204:**

$2mF_o-DF_c$ (at 0.7 rmsd) in gray
 mF_o-DF_c (at 3 rmsd) in purple (negative)
and green (positive)



5.5 Other polymers [i](#)

There are no such residues in this entry.