wwPDB X-ray Structure Validation Summary Report (i)

Feb 1, 2016 – 10:14 PM GMT

PDB ID	:	4X4Q
Title	:	Crystal structure of the A.fulgidus CCA-adding enzyme in complex with a G70A arginyl-tRNA minihelix ending in CCAC and CTP
Authors	:	Kuhn, C.-D.; Joshua-Tor, L.
Deposited on	:	2014-12-03
Resolution	:	3.15 Å(reported)

This is a wwPDB X-ray Structure Validation Summary 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/validation/2016/XrayValidationReportHelp
with specific help available everywhere you see the (i) symbol.

The following versions of software and data (see references (1)) were used in the production of this report:

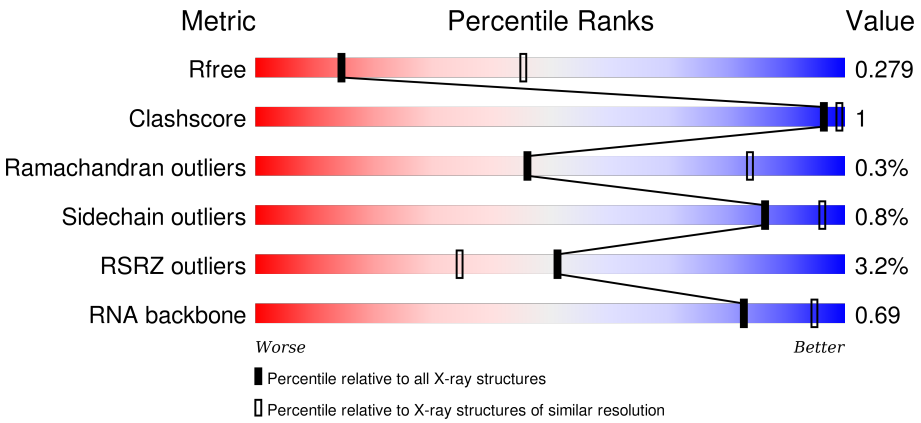
MolProbity	:	4.02b-467
Mogul	:	1.7 (RC4), CSD as536be (2015)
Xtriage (Phenix)	:	1.9-1692
EDS	:	rb-20026688
Percentile statistics	:	20151230.v01 (using entries in the PDB archive December 30th 2015)
Refmac	:	5.8.0135
CCP4	:	6.5.0
Ideal geometry (proteins)	:	Engh & Huber (2001)
Ideal geometry (DNA, RNA)	:	Parkinson et al. (1996)
Validation Pipeline (wwPDB-VP)	:	trunk26865

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 3.15 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}	91344	1112 (3.20-3.12)
Clashscore	102246	1249 (3.20-3.12)
Ramachandran outliers	100387	1222 (3.20-3.12)
Sidechain outliers	100360	1221 (3.20-3.12)
RSRZ outliers	91569	1117 (3.20-3.12)
RNA backbone	2183	1046 (3.62-2.70)

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. 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	457	92% 5% •
1	C	457	5% 91% • •
2	B	36	8% 78% 14% 8%
2	D	36	6% 78% 6% 17%

The following table lists non-polymeric compounds, carbohydrate monomers and non-standard residues in protein, DNA, RNA chains that are outliers for geometric or electron-density-fit criteria:

Mol	Type	Chain	Res	Chirality	Geometry	Clashes	Electron density
3	MG	A	502	-	-	-	X
5	PEG	A	506	-	-	-	X
5	PEG	C	503	-	-	-	X
6	GOL	A	505	-	-	-	X

2 Entry composition (i)

There are 7 unique types of molecules in this entry. The entry contains 16942 atoms, of which 8118 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 CCA-adding enzyme.

Mol	Chain	Residues	Atoms						ZeroOcc	AltConf	Trace
			Total	C	H	N	O	S			
1	A	443	7354	2359	3680	640	662	13	0	1	0
1	C	437	7285	2338	3649	634	651	13	0	1	0

There are 40 discrepancies between the modelled and reference sequences:

Chain	Residue	Modelled	Actual	Comment	Reference
A	438	SER	-	expression tag	UNP O28126
A	439	ASN	-	expression tag	UNP O28126
A	440	SER	-	expression tag	UNP O28126
A	441	SER	-	expression tag	UNP O28126
A	442	SER	-	expression tag	UNP O28126
A	443	VAL	-	expression tag	UNP O28126
A	444	ASP	-	expression tag	UNP O28126
A	445	LYS	-	expression tag	UNP O28126
A	446	LEU	-	expression tag	UNP O28126
A	447	ALA	-	expression tag	UNP O28126
A	448	ALA	-	expression tag	UNP O28126
A	449	ALA	-	expression tag	UNP O28126
A	450	LEU	-	expression tag	UNP O28126
A	451	GLU	-	expression tag	UNP O28126
A	452	HIS	-	expression tag	UNP O28126
A	453	HIS	-	expression tag	UNP O28126
A	454	HIS	-	expression tag	UNP O28126
A	455	HIS	-	expression tag	UNP O28126
A	456	HIS	-	expression tag	UNP O28126
A	457	HIS	-	expression tag	UNP O28126
C	438	SER	-	expression tag	UNP O28126
C	439	ASN	-	expression tag	UNP O28126
C	440	SER	-	expression tag	UNP O28126
C	441	SER	-	expression tag	UNP O28126
C	442	SER	-	expression tag	UNP O28126

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Chain	Residue	Modelled	Actual	Comment	Reference
C	443	VAL	-	expression tag	UNP O28126
C	444	ASP	-	expression tag	UNP O28126
C	445	LYS	-	expression tag	UNP O28126
C	446	LEU	-	expression tag	UNP O28126
C	447	ALA	-	expression tag	UNP O28126
C	448	ALA	-	expression tag	UNP O28126
C	449	ALA	-	expression tag	UNP O28126
C	450	LEU	-	expression tag	UNP O28126
C	451	GLU	-	expression tag	UNP O28126
C	452	HIS	-	expression tag	UNP O28126
C	453	HIS	-	expression tag	UNP O28126
C	454	HIS	-	expression tag	UNP O28126
C	455	HIS	-	expression tag	UNP O28126
C	456	HIS	-	expression tag	UNP O28126
C	457	HIS	-	expression tag	UNP O28126

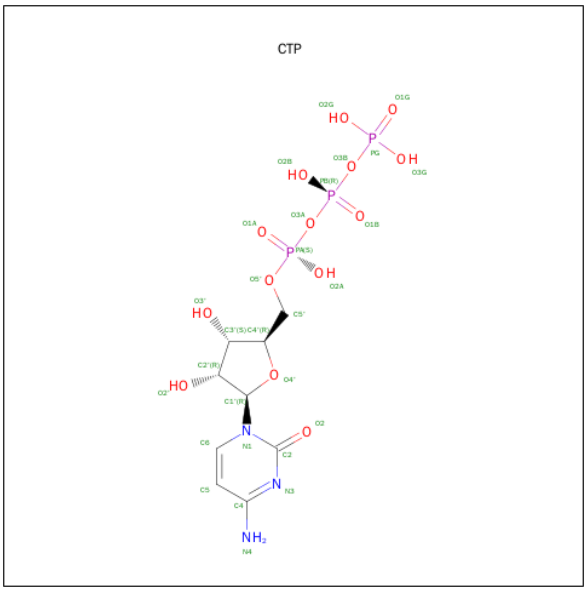
- Molecule 2 is a RNA chain called G70A tRNA minihelix ending in CCAC.

Mol	Chain	Residues	Atoms						ZeroOcc	AltConf	Trace
			Total	C	H	N	O	P			
2	B	36	1160	341	392	137	254	36	0	0	0
2	D	30	967	284	327	114	212	30	0	0	0

- Molecule 3 is MAGNESIUM ION (three-letter code: MG) (formula: Mg).

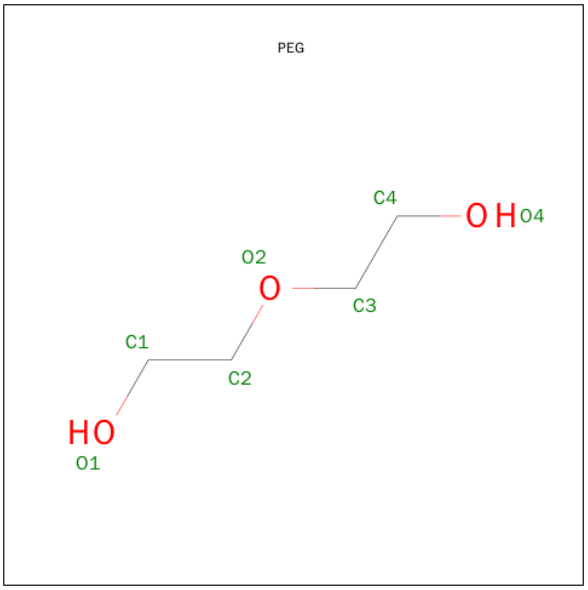
Mol	Chain	Residues	Atoms		ZeroOcc	AltConf
			Total	Mg		
3	A	2	2	2	0	0
3	C	1	1	1	0	0

- Molecule 4 is CYTIDINE-5'-TRIPHOSPHATE (three-letter code: CTP) (formula: $C_9H_{16}N_3O_{14}P_3$).



Mol	Chain	Residues	Atoms						ZeroOcc	AltConf
			Total	C	H	N	O	P		
4	A	1	41	9	12	3	14	3	0	0
4	C	1	41	9	12	3	14	3	0	0

- Molecule 5 is DI(HYDROXYETHYL)ETHER (three-letter code: PEG) (formula: $C_4H_{10}O_3$).



Mol	Chain	Residues	Atoms				ZeroOcc	AltConf
			Total	C	H	O		
5	A	1	17	4	10	3	0	0
5	A	1	17	4	10	3	0	0

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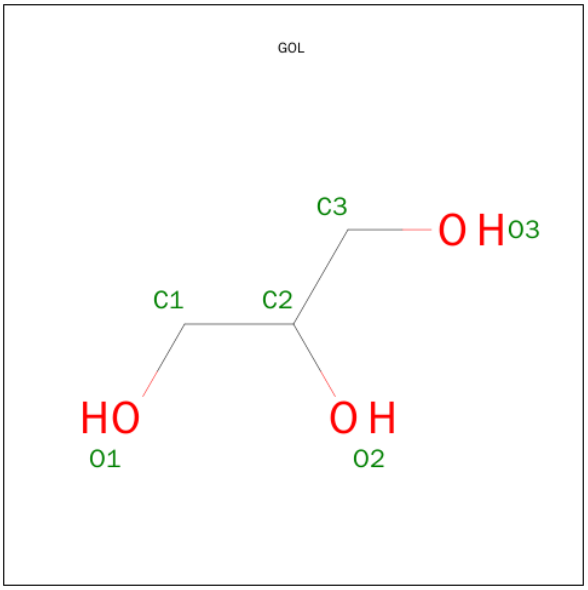
Mol	Chain	Residues	Atoms				ZeroOcc	AltConf
			Total	C	H	O		
5	C	1	17	4	10	3	0	0

- Molecule 6 is GLYCEROL (three-letter code: GOL) (formula: $C_3H_8O_3$).



Mol	Chain	Residues	Atoms				ZeroOcc	AltConf
			Total	C	H	O		
6	A	1	14	3	8	3	0	0
6	B	1	14	3	8	3	0	0

- Molecule 7 is water.

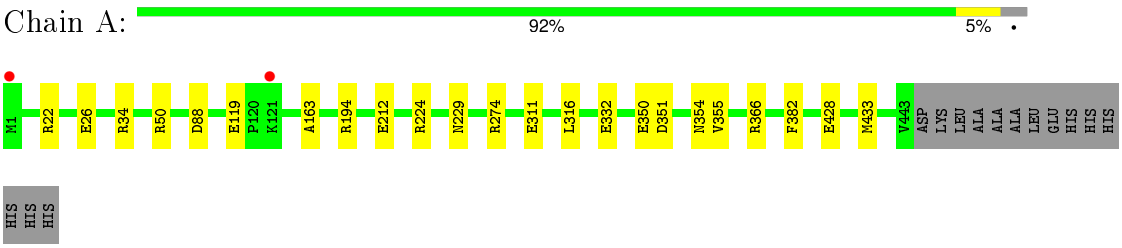
Mol	Chain	Residues	Atoms		ZeroOcc	AltConf
			Total	O		
7	A	4	4	4	0	0
7	B	5	5	5	0	0
7	C	2	2	2	0	0
7	D	1	1	1	0	0

3 Residue-property plots (i)

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.

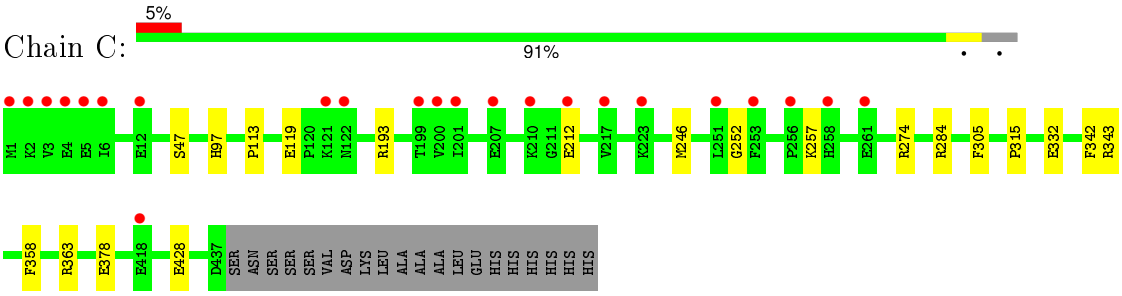
- Molecule 1: CCA-adding enzyme

Chain A:



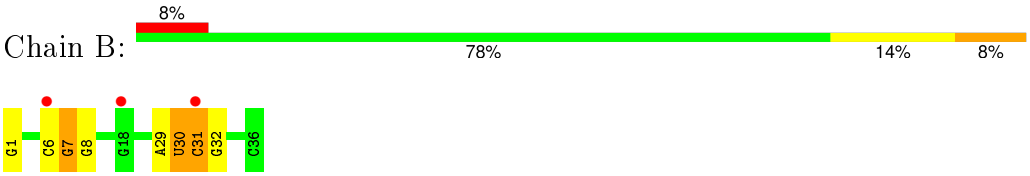
- Molecule 1: CCA-adding enzyme

Chain C:



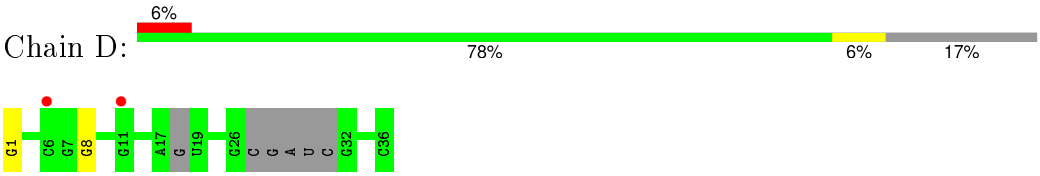
- Molecule 2: G70A tRNA minihelix ending in CCAC

Chain B:



- Molecule 2: G70A tRNA minihelix ending in CCAC

Chain D:



4 Data and refinement statistics (i)

Property	Value	Source
Space group	P 21 21 2	Depositor
Cell constants a, b, c, α, β, γ	111.48Å 215.58Å 58.47Å 90.00° 90.00° 90.00°	Depositor
Resolution (Å)	49.51 – 3.15 49.51 – 3.08	Depositor EDS
% Data completeness (in resolution range)	98.6 (49.51-3.15) 94.2 (49.51-3.08)	Depositor EDS
R_{merge}	0.10	Depositor
R_{sym}	(Not available)	Depositor
$< I/\sigma(I) >$ [1]	3.72 (at 3.07Å)	Xtriage
Refinement program	PHENIX (phenix.refine: 1.8.2_1309)	Depositor
R, R_{free}	0.226 , 0.284 0.226 , 0.279	Depositor DCC
R_{free} test set	1267 reflections (5.55%)	DCC
Wilson B-factor (Å^2)	52.2	Xtriage
Anisotropy	0.209	Xtriage
Bulk solvent k_{sol}(e/Å^3), B_{sol}(Å^2)	0.35 , 33.5	EDS
Estimated twinning fraction	No twinning to report.	Xtriage
L-test for twinning[2]	$< \|L\| > = 0.48$, $< L^2 > = 0.31$	Xtriage
Outliers	0 of 26441 reflections	Xtriage
F_o,F_c correlation	0.89	EDS
Total number of atoms	16942	wwPDB-VP
Average B, all atoms (Å^2)	85.0	wwPDB-VP

Xtriage's analysis on translational NCS is as follows: *The largest off-origin peak in the Patterson function is 3.83% 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, 0.375 respectively for untwinned datasets, and 0.333, 0.2 for perfectly twinned datasets.

5 Model quality (i)

5.1 Standard geometry (i)

Bond lengths and bond angles in the following residue types are not validated in this section: GOL, MG, PEG, CTP

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	0.26	0/3761	0.43	0/5054
1	C	0.27	0/3723	0.42	0/5003
2	B	0.42	1/856 (0.1%)	0.74	0/1331
2	D	0.43	1/711 (0.1%)	0.70	0/1100
All	All	0.30	2/9051 (0.0%)	0.50	0/12488

All (2) bond length outliers are listed below:

Mol	Chain	Res	Type	Atoms	Z	Observed(Å)	Ideal(Å)
2	B	1	G	OP3-P	-10.62	1.48	1.61
2	D	1	G	OP3-P	-10.15	1.49	1.61

There are no bond angle outliers.

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	3674	3680	3671	12	0
1	C	3636	3649	3640	11	0
2	B	768	392	392	2	0
2	D	640	327	329	0	0
3	A	2	0	0	0	0

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Mol	Chain	Non-H	H(model)	H(added)	Clashes	Symm-Clashes
3	C	1	0	0	0	0
4	A	29	12	12	0	0
4	C	29	12	12	1	0
5	A	14	20	18	1	0
5	C	7	10	9	0	0
6	A	6	8	8	0	0
6	B	6	8	8	0	0
7	A	4	0	0	1	0
7	B	5	0	0	0	0
7	C	2	0	0	0	0
7	D	1	0	0	0	0
All	All	8824	8118	8099	24	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 1.

The worst 5 of 24 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:C:358:PHE:O	1:C:363:ARG:NH2	2.17	0.77
1:A:50:ARG:NH2	7:A:604:HOH:O	2.21	0.73
1:A:274:ARG:NH2	1:A:433:MET:O	2.28	0.66
1:A:274:ARG:NH1	1:A:332:GLU:OE2	2.29	0.65
1:C:97[B]:HIS:NE2	1:C:113:PRO:O	2.35	0.58

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	442/457 (97%)	425 (96%)	15 (3%)	2 (0%)	34 76

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Mol	Chain	Analysed	Favoured	Allowed	Outliers	Percentiles	
1	C	436/457 (95%)	419 (96%)	16 (4%)	1 (0%)	52	88
All	All	878/914 (96%)	844 (96%)	31 (4%)	3 (0%)	46	84

All (3) Ramachandran outliers are listed below:

Mol	Chain	Res	Type
1	A	119	GLU
1	C	119	GLU
1	A	366	ARG

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	393/404 (97%)	389 (99%)	4 (1%)	82	94
1	C	388/404 (96%)	386 (100%)	2 (0%)	92	97
All	All	781/808 (97%)	775 (99%)	6 (1%)	86	96

5 of 6 residues with a non-rotameric sidechain are listed below:

Mol	Chain	Res	Type
1	A	224	ARG
1	C	284	ARG
1	A	350	GLU
1	A	212	GLU
1	C	212	GLU

Some sidechains can be flipped to improve hydrogen bonding and reduce clashes. All (1) such sidechains are listed below:

Mol	Chain	Res	Type
1	A	240	HIS

5.3.3 RNA (i)

Mol	Chain	Analysed	Backbone Outliers	Pucker Outliers
2	B	35/36 (97%)	5 (14%)	1 (2%)
2	D	27/36 (75%)	1 (3%)	0
All	All	62/72 (86%)	6 (9%)	1 (1%)

5 of 6 RNA backbone outliers are listed below:

Mol	Chain	Res	Type
2	B	7	G
2	B	8	G
2	B	29	A
2	B	31	C
2	B	32	G

All (1) RNA pucker outliers are listed below:

Mol	Chain	Res	Type
2	B	30	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 carbohydrates in this entry.

5.6 Ligand geometry (i)

Of 10 ligands modelled in this entry, 3 are monoatomic - leaving 7 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	$\#\|Z\| > 2$
4	CTP	A	503	3	21,30,30	0.82	0	31,47,47	1.27	4 (12%)
5	PEG	A	504	-	6,6,6	0.61	0	5,5,5	0.34	0
6	GOL	A	505	-	5,5,5	0.31	0	5,5,5	0.27	0
5	PEG	A	506	-	6,6,6	0.58	0	5,5,5	0.39	0
6	GOL	B	101	-	5,5,5	0.36	0	5,5,5	0.24	0
4	CTP	C	501	3	21,30,30	0.78	0	31,47,47	1.35	4 (12%)
5	PEG	C	503	-	6,6,6	0.59	0	5,5,5	0.35	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
4	CTP	A	503	3	-	0/18/38/38	0/2/2/2
5	PEG	A	504	-	-	0/4/4/4	0/0/0/0
6	GOL	A	505	-	-	0/4/4/4	0/0/0/0
5	PEG	A	506	-	-	0/4/4/4	0/0/0/0
6	GOL	B	101	-	-	0/4/4/4	0/0/0/0
4	CTP	C	501	3	-	0/18/38/38	0/2/2/2
5	PEG	C	503	-	-	0/4/4/4	0/0/0/0

There are no bond length outliers.

The worst 5 of 8 bond angle outliers are listed below:

Mol	Chain	Res	Type	Atoms	Z	Observed(^{o})	Ideal(^{o})
4	C	501	CTP	PB-O3A-PA	-3.47	122.98	132.73
4	A	503	CTP	PB-O3A-PA	-2.76	124.98	132.73
4	A	503	CTP	PB-O3B-PG	-2.30	124.96	132.67
4	C	501	CTP	PB-O3B-PG	-2.14	125.50	132.67
4	C	501	CTP	N4-C4-N3	2.25	120.60	116.50

There are no chirality outliers.

There are no torsion outliers.

There are no ring outliers.

2 monomers are involved in 2 short contacts:

Mol	Chain	Res	Type	Clashes	Symm-Clashes
5	A	504	PEG	1	0
4	C	501	CTP	1	0

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	443/457 (96%)	0.04	2 (0%)	91	87	43, 67, 102, 146	0
1	C	437/457 (95%)	0.28	23 (5%)	30	16	44, 72, 105, 178	0
2	B	36/36 (100%)	0.73	3 (8%)	14	6	56, 126, 196, 212	0
2	D	30/36 (83%)	0.73	2 (6%)	21	11	66, 122, 170, 181	0
All	All	946/986 (95%)	0.20	30 (3%)	51	34	43, 70, 125, 212	0

The worst 5 of 30 RSRZ outliers are listed below:

Mol	Chain	Res	Type	RSRZ
1	C	1	MET	6.4
1	C	212	GLU	4.9
1	C	207	GLU	4.6
1	C	121	LYS	4.4
2	B	18	G	3.6

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 carbohydrates in this entry.

6.4 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. 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	RSCC	RSR	LLDF	B-factors(Å^2)	Q<0.9
3	MG	A	502	1/1	0.91	0.35	2.98	72,72,72,72	0
5	PEG	A	506	7/7	0.77	0.31	2.96	67,81,86,87	0
5	PEG	C	503	7/7	0.75	0.35	2.15	76,91,103,103	0
6	GOL	A	505	6/6	0.85	0.34	2.06	62,75,91,91	0
5	PEG	A	504	7/7	0.76	0.29	0.86	72,87,105,105	0
4	CTP	C	501	29/29	0.92	0.17	-0.93	83,96,112,120	0
4	CTP	A	503	29/29	0.96	0.19	-1.62	48,59,70,75	0
3	MG	C	502	1/1	0.92	0.13	-	82,82,82,82	0
3	MG	A	501	1/1	0.95	0.21	-	59,59,59,59	0
6	GOL	B	101	6/6	0.70	0.34	-	65,79,95,95	0

6.5 Other polymers (i)

There are no such residues in this entry.