



Full wwPDB X-ray Structure Validation Report ⓘ

Mar 8, 2026 – 10:33 PM UTC

PDB ID : 1CSI / pdb_00001csi
Title : A very short hydrogen bond provides only moderate stabilization of an enzyme:
inhibitor complex of citrate synthase
Authors : Usher, K.C.; Remington, S.J.
Deposited on : 1994-03-07
Resolution : 1.70 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
Mogul	:	2022.3.0, CSD as543be (2022)
Xtriage (Phenix)	:	NOT EXECUTED
EDS	:	NOT EXECUTED
Buster-report	:	wwPDB partial adaption of 1.1.7 (2018)
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

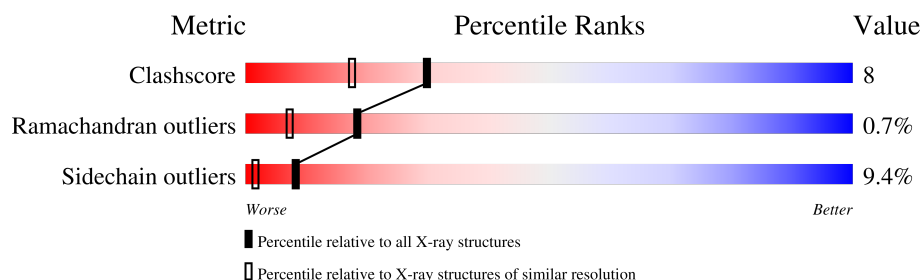
1 Overall quality at a glance

The following experimental techniques were used to determine the structure:

X-RAY DIFFRACTION

The reported resolution of this entry is 1.70 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	5924 (1.70-1.70)
Ramachandran outliers	187476	5846 (1.70-1.70)
Sidechain outliers	187428	5846 (1.70-1.70)

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 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	435	 72% 21% 6%

2 Entry composition

There are 4 unique types of molecules in this entry. The entry contains 3594 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.

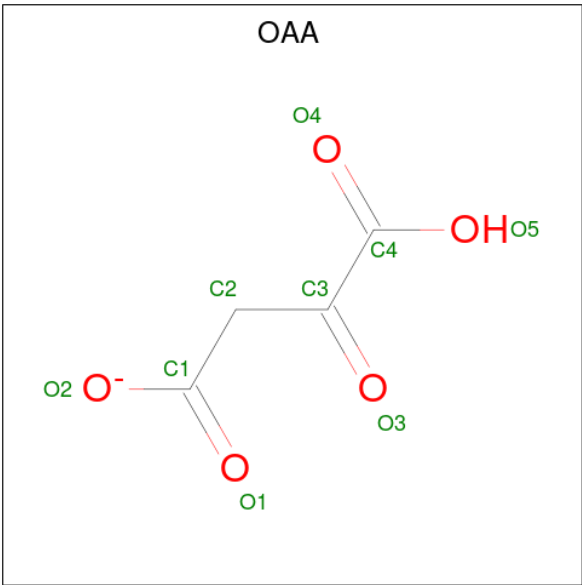
- Molecule 1 is a protein called CITRATE SYNTHASE.

Mol	Chain	Residues	Atoms					ZeroOcc	AltConf	Trace
1	A	435	Total	C	N	O	S	0	0	0
			3391	2167	583	625	16			

There are 25 discrepancies between the modelled and reference sequences:

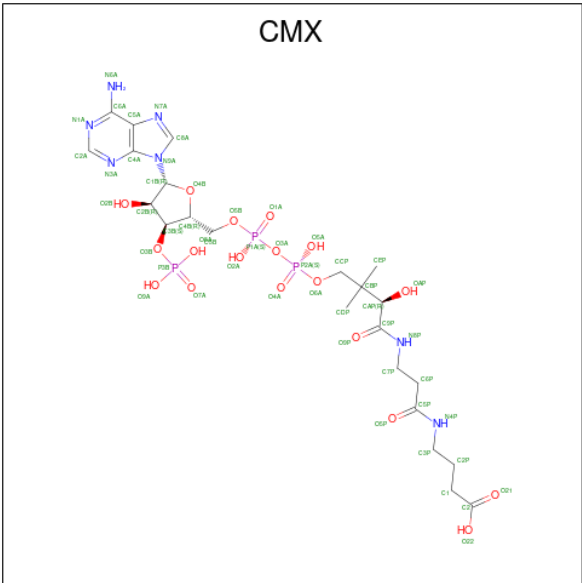
Chain	Residue	Modelled	Actual	Comment	Reference
A	9	VAL	ILE	conflict	UNP P23007
A	12	SER	ASP	conflict	UNP P23007
A	32	ALA	VAL	conflict	UNP P23007
A	41	SER	MET	conflict	UNP P23007
A	52	ILE	VAL	conflict	UNP P23007
A	69	PHE	TYR	conflict	UNP P23007
A	77	LEU	MET	conflict	UNP P23007
A	82	GLY	LYS	conflict	UNP P23007
A	104	PRO	GLU	conflict	UNP P23007
A	110	VAL	LEU	conflict	UNP P23007
A	163	ASN	HIS	conflict	UNP P23007
A	170	PHE	LEU	conflict	UNP P23007
A	171	VAL	ILE	conflict	UNP P23007
A	175	ALA	CYS	conflict	UNP P23007
A	196	ALA	GLU	conflict	UNP P23007
A	222	PRO	ALA	conflict	UNP P23007
A	283	LEU	VAL	conflict	UNP P23007
A	286	SER	THR	conflict	UNP P23007
A	291	ASP	GLU	conflict	UNP P23007
A	292	LEU	VAL	conflict	UNP P23007
A	294	ALA	LYS	conflict	UNP P23007
A	296	ALA	VAL	conflict	UNP P23007
A	343	SER	HIS	conflict	UNP P23007
A	428	ALA	ASP	conflict	UNP P23007
A	431	GLU	ILE	conflict	UNP P23007

- Molecule 2 is OXALOACETATE ION (CCD ID: OAA) (formula: $C_4H_3O_5$).



Mol	Chain	Residues	Atoms			ZeroOcc	AltConf
2	A	1	Total	C	O	0	0
			9	4	5		

- Molecule 3 is CARBOXYMETHYLDETHIA COENZYME *A (CCD ID: CMX) (formula: $C_{23}H_{38}N_7O_{18}P_3$).



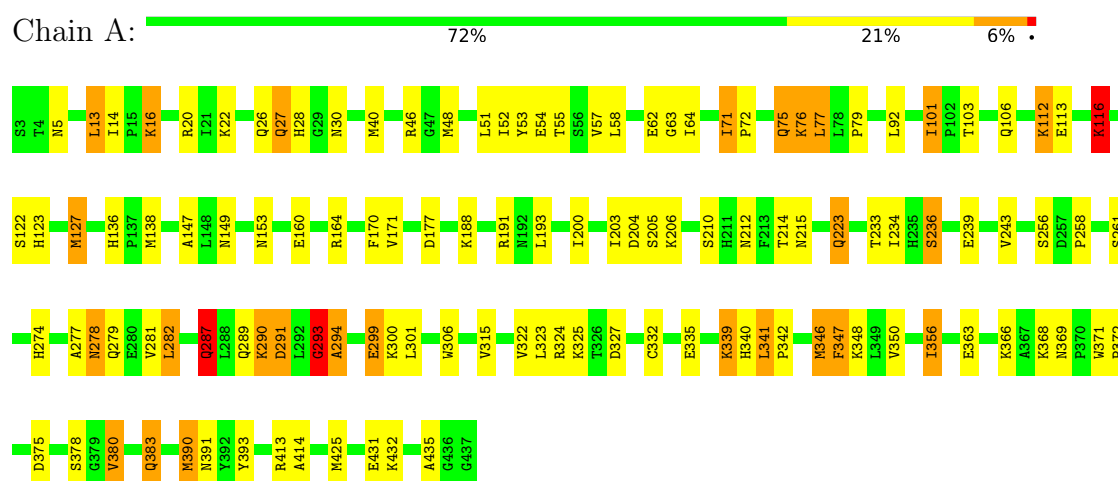
Mol	Chain	Residues	Atoms		ZeroOcc	AltConf
4	A	143	Total 143	O 143	0	0

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: CITRATE SYNTHASE



4 Data and refinement statistics

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

Property	Value	Source
Space group	C 1 2 1	Depositor
Cell constants a, b, c, α , β , γ	104.40Å 78.50Å 58.50Å 90.00° 78.90° 90.00°	Depositor
Resolution (Å)	25.00 – 1.70	Depositor
% Data completeness (in resolution range)	(Not available) (25.00-1.70)	Depositor
R_{merge}	(Not available)	Depositor
R_{sym}	(Not available)	Depositor
Refinement program	TNT	Depositor
R, R_{free}	0.156 , (Not available)	Depositor
Estimated twinning fraction	No twinning to report.	Xtriage
Total number of atoms	3594	wwPDB-VP
Average B, all atoms (Å ²)	16.0	wwPDB-VP

5 Model quality

5.1 Standard geometry

Bond lengths and bond angles in the following residue types are not validated in this section: OAA, CMX

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	1.15	2/3476 (0.1%)	1.69	50/4721 (1.1%)

All (2) bond length outliers are listed below:

Mol	Chain	Res	Type	Atoms	Z	Observed(Å)	Ideal(Å)
1	A	71	ILE	CA-CB	-8.79	1.49	1.54
1	A	239	GLU	CD-OE1	5.11	1.35	1.25

All (50) bond angle outliers are listed below:

Mol	Chain	Res	Type	Atoms	Z	Observed(°)	Ideal(°)
1	A	13	LEU	CD1-CG-CD2	-9.47	89.95	110.80
1	A	54	GLU	N-CA-C	9.21	123.84	112.23
1	A	315	VAL	N-CA-C	-9.14	98.53	107.76
1	A	236	SER	N-CA-C	8.94	121.83	111.11
1	A	340	HIS	N-CA-C	8.86	124.22	113.41
1	A	30	ASN	CA-CB-CG	-8.73	103.87	112.60
1	A	64	ILE	N-CA-C	8.43	120.45	109.58
1	A	243	VAL	N-CA-C	8.22	118.99	110.36
1	A	356	ILE	N-CA-C	8.02	119.29	111.67
1	A	170	PHE	CA-CB-CG	-7.81	105.99	113.80
1	A	51	LEU	CB-CA-C	-7.74	93.05	110.07
1	A	274	HIS	CA-C-O	6.95	122.71	118.33
1	A	77	LEU	N-CA-C	6.89	120.91	112.23
1	A	383	GLN	CB-CG-CD	6.88	124.29	112.60
1	A	46	ARG	NE-CZ-NH2	6.76	125.28	119.20
1	A	390	MET	N-CA-C	6.57	119.26	111.71
1	A	278	ASN	CA-CB-CG	6.53	119.13	112.60
1	A	55	THR	N-CA-C	6.51	118.38	111.28
1	A	339	LYS	N-CA-CB	6.38	119.70	110.20

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Mol	Chain	Res	Type	Atoms	Z	Observed(°)	Ideal(°)
1	A	122	SER	N-CA-C	6.37	119.04	111.71
1	A	378	SER	N-CA-C	6.37	118.10	111.03
1	A	256	SER	N-CA-C	-6.22	101.73	110.50
1	A	28	HIS	N-CA-C	6.17	121.64	112.94
1	A	287	GLN	CB-CG-CD	-6.10	102.23	112.60
1	A	278	ASN	N-CA-CB	5.93	119.36	110.22
1	A	380	VAL	CA-CB-CG2	-5.91	100.36	110.40
1	A	53	TYR	CB-CA-C	5.82	118.74	110.24
1	A	28	HIS	N-CA-CB	-5.78	101.44	110.98
1	A	291	ASP	CA-CB-CG	5.75	118.35	112.60
1	A	57	VAL	CA-C-N	-5.69	115.15	123.00
1	A	57	VAL	C-N-CA	-5.69	115.15	123.00
1	A	347	PHE	N-CA-C	-5.58	105.09	111.07
1	A	294	ALA	N-CA-C	5.45	122.41	110.80
1	A	393	TYR	N-CA-C	5.42	117.19	111.28
1	A	332	CYS	CB-CA-C	5.40	120.62	110.63
1	A	75	GLN	CA-C-O	5.38	126.44	120.63
1	A	383	GLN	CA-CB-CG	5.35	124.79	114.10
1	A	116	LYS	N-CA-CB	5.33	118.55	110.28
1	A	372	PRO	N-CA-CB	5.30	108.26	103.33
1	A	327	ASP	CA-CB-CG	5.24	117.84	112.60
1	A	177	ASP	CA-CB-CG	5.21	117.81	112.60
1	A	431	GLU	N-CA-C	-5.19	105.52	111.07
1	A	239	GLU	CB-CA-C	5.14	120.66	110.42
1	A	322	VAL	N-CA-CB	-5.10	104.91	111.90
1	A	79	PRO	N-CA-CB	5.08	107.83	103.31
1	A	27	GLN	N-CA-C	5.08	116.89	111.36
1	A	332	CYS	CA-C-O	5.03	125.78	120.10
1	A	293	GLY	CA-C-N	5.02	131.13	121.54
1	A	293	GLY	C-N-CA	5.02	131.13	121.54
1	A	234	ILE	N-CA-C	5.02	119.07	112.04

There are no chirality outliers.

There are no planarity outliers.

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	3391	0	3370	58	0
2	A	9	0	2	0	0
3	A	51	0	33	3	0
4	A	143	0	0	1	0
All	All	3594	0	3405	58	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 8.

All (58) 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:136:HIS:HD2	1:A:138:MET:H	1.28	0.82
1:A:346:MET:HG2	1:A:380:VAL:HG22	1.68	0.76
1:A:299:GLU:H	1:A:299:GLU:CD	2.02	0.68
1:A:112:LYS:O	1:A:116:LYS:HG3	1.95	0.66
1:A:92:LEU:HD21	1:A:236:SER:OG	1.96	0.66
1:A:339:LYS:N	1:A:339:LYS:HD3	2.13	0.64
1:A:136:HIS:CD2	1:A:138:MET:H	2.14	0.63
1:A:171:VAL:HG21	1:A:413:ARG:HG3	1.83	0.59
1:A:77:LEU:HB3	1:A:101:ILE:HD12	1.85	0.59
1:A:301:LEU:HD12	1:A:356:ILE:HD12	1.84	0.58
1:A:103:THR:H	1:A:106:GLN:HE21	1.52	0.57
1:A:223:GLN:OE1	1:A:223:GLN:HA	1.99	0.57
1:A:335:GLU:O	1:A:339:LYS:HE2	2.06	0.56
1:A:210:SER:O	1:A:214:THR:HG23	2.06	0.56
1:A:306:TRP:CZ2	1:A:363:GLU:OE2	2.58	0.56
1:A:103:THR:H	1:A:106:GLN:NE2	2.04	0.56
1:A:366:LYS:HE3	3:A:700:CMX:O8A	2.06	0.56
1:A:301:LEU:HD12	1:A:356:ILE:CD1	2.37	0.55
1:A:289:GLN:O	1:A:293:GLY:HA2	2.08	0.53
1:A:350:VAL:HG21	1:A:380:VAL:HG21	1.91	0.53
1:A:215:ASN:ND2	4:A:581:HOH:O	2.42	0.52
1:A:324:ARG:C	1:A:325:LYS:HG2	2.34	0.52
1:A:341:LEU:N	1:A:342:PRO:HD3	2.24	0.52
1:A:306:TRP:HZ2	1:A:363:GLU:OE2	1.93	0.50
1:A:301:LEU:CD1	1:A:356:ILE:HD12	2.40	0.50
1:A:191:ARG:HG3	1:A:200:ILE:HG22	1.93	0.50
1:A:71:ILE:HB	1:A:72:PRO:HD3	1.94	0.49
1:A:258:PRO:HA	1:A:261:SER:OG	2.14	0.47
1:A:341:LEU:N	1:A:342:PRO:CD	2.77	0.47
1:A:204:ASP:H	1:A:212:ASN:HD21	1.61	0.47

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Atom-1	Atom-2	Interatomic distance (Å)	Clash overlap (Å)
1:A:346:MET:HG2	1:A:380:VAL:CG2	2.42	0.46
1:A:287:GLN:HA	1:A:290:LYS:HE2	1.99	0.45
1:A:22:LYS:O	1:A:26:GLN:HG3	2.16	0.45
1:A:5:ASN:C	1:A:5:ASN:HD22	2.25	0.45
1:A:347:PHE:HA	1:A:380:VAL:HG11	1.99	0.45
1:A:204:ASP:OD1	1:A:206:LYS:HB2	2.18	0.44
1:A:92:LEU:HD22	1:A:233:THR:HG23	2.00	0.44
1:A:63:GLY:HA2	1:A:323:LEU:HD21	2.00	0.43
1:A:136:HIS:HE1	1:A:279:GLN:OE1	2.01	0.43
1:A:339:LYS:HD3	1:A:339:LYS:HA	1.75	0.43
1:A:127:MET:HE1	1:A:147:ALA:HB3	2.01	0.43
1:A:123:HIS:HE1	1:A:147:ALA:O	2.00	0.43
1:A:16:LYS:H	1:A:16:LYS:HG2	1.29	0.43
1:A:369:ASN:OD1	1:A:371:TRP:HD1	2.02	0.43
1:A:14:ILE:HG12	1:A:414:ALA:HB1	2.01	0.42
1:A:58:LEU:HD12	1:A:63:GLY:C	2.43	0.42
1:A:52:ILE:HD13	1:A:52:ILE:HA	1.86	0.42
1:A:76:LYS:HB2	1:A:76:LYS:HE3	1.39	0.42
1:A:277:ALA:O	1:A:281:VAL:HG23	2.19	0.42
1:A:375:ASP:OD2	3:A:700:CMX:O22	2.38	0.42
1:A:282:LEU:HD13	1:A:282:LEU:HA	1.70	0.42
1:A:112:LYS:HB2	1:A:112:LYS:HE2	1.73	0.41
1:A:113:GLU:OE1	1:A:116:LYS:HE2	2.20	0.41
1:A:206:LYS:HD3	1:A:206:LYS:HA	1.60	0.41
1:A:391:ASN:N	1:A:391:ASN:HD22	2.16	0.41
1:A:40:MET:SD	1:A:48:MET:HG2	2.61	0.41
1:A:153:ASN:N	1:A:153:ASN:ND2	2.69	0.41
1:A:366:LYS:HE2	3:A:700:CMX:O3B	2.21	0.41

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	433/435 (100%)	421 (97%)	9 (2%)	3 (1%)	18 7

All (3) Ramachandran outliers are listed below:

Mol	Chain	Res	Type
1	A	294	ALA
1	A	435	ALA
1	A	293	GLY

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	361/361 (100%)	327 (91%)	34 (9%)	8 1

All (34) residues with a non-rotameric sidechain are listed below:

Mol	Chain	Res	Type
1	A	13	LEU
1	A	16	LYS
1	A	20	ARG
1	A	27	GLN
1	A	62	GLU
1	A	75	GLN
1	A	76	LYS
1	A	101	ILE
1	A	112	LYS
1	A	116	LYS
1	A	127	MET
1	A	149	ASN
1	A	160	GLU
1	A	164	ARG
1	A	188	LYS
1	A	193	LEU
1	A	203	ILE
1	A	205	SER

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Mol	Chain	Res	Type
1	A	223	GLN
1	A	278	ASN
1	A	282	LEU
1	A	287	GLN
1	A	290	LYS
1	A	291	ASP
1	A	299	GLU
1	A	300	LYS
1	A	341	LEU
1	A	346	MET
1	A	348	LYS
1	A	368	LYS
1	A	383	GLN
1	A	390	MET
1	A	425	MET
1	A	432	LYS

Sometimes sidechains can be flipped to improve hydrogen bonding and reduce clashes. All (18) such sidechains are listed below:

Mol	Chain	Res	Type
1	A	5	ASN
1	A	26	GLN
1	A	106	GLN
1	A	123	HIS
1	A	130	ASN
1	A	136	HIS
1	A	140	GLN
1	A	153	ASN
1	A	192	ASN
1	A	211	HIS
1	A	212	ASN
1	A	215	ASN
1	A	267	ASN
1	A	278	ASN
1	A	289	GLN
1	A	352	GLN
1	A	364	GLN
1	A	391	ASN

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 ⓘ

There are no oligosaccharides in this entry.

5.6 Ligand geometry ⓘ

2 ligands 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	$\# Z > 2$
2	OAA	A	702	-	8,8,8	1.06	0	8,10,10	1.47	2 (25%)
3	CMX	A	700	-	51,53,53	0.92	1 (1%)	74,79,79	1.12	8 (10%)

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
2	OAA	A	702	-	-	0/8/8/8	-
3	CMX	A	700	-	-	3/51/67/67	0/3/3/3

All (1) bond length outliers are listed below:

Mol	Chain	Res	Type	Atoms	Z	Observed(Å)	Ideal(Å)
3	A	700	CMX	P2A-O3A	2.91	1.62	1.59

All (10) bond angle outliers are listed below:

Mol	Chain	Res	Type	Atoms	Z	Observed(°)	Ideal(°)
3	A	700	CMX	O4B-C1B-C2B	-3.10	99.99	106.62
3	A	700	CMX	C2B-C1B-N9A	-2.97	105.92	113.30
2	A	702	OAA	O3-C3-C2	2.60	124.40	120.41
3	A	700	CMX	CDP-CBP-CAP	2.58	113.17	108.77
2	A	702	OAA	O1-C1-C2	-2.54	114.86	122.11
3	A	700	CMX	C1B-N9A-C8A	-2.40	121.77	127.09
3	A	700	CMX	O4B-C1B-N9A	2.26	112.44	108.09
3	A	700	CMX	C4A-N9A-C1B	2.26	131.91	126.63
3	A	700	CMX	O5A-P2A-O4A	2.16	122.51	112.44
3	A	700	CMX	C3P-N4P-C5P	-2.08	118.95	122.82

There are no chirality outliers.

All (3) torsion outliers are listed below:

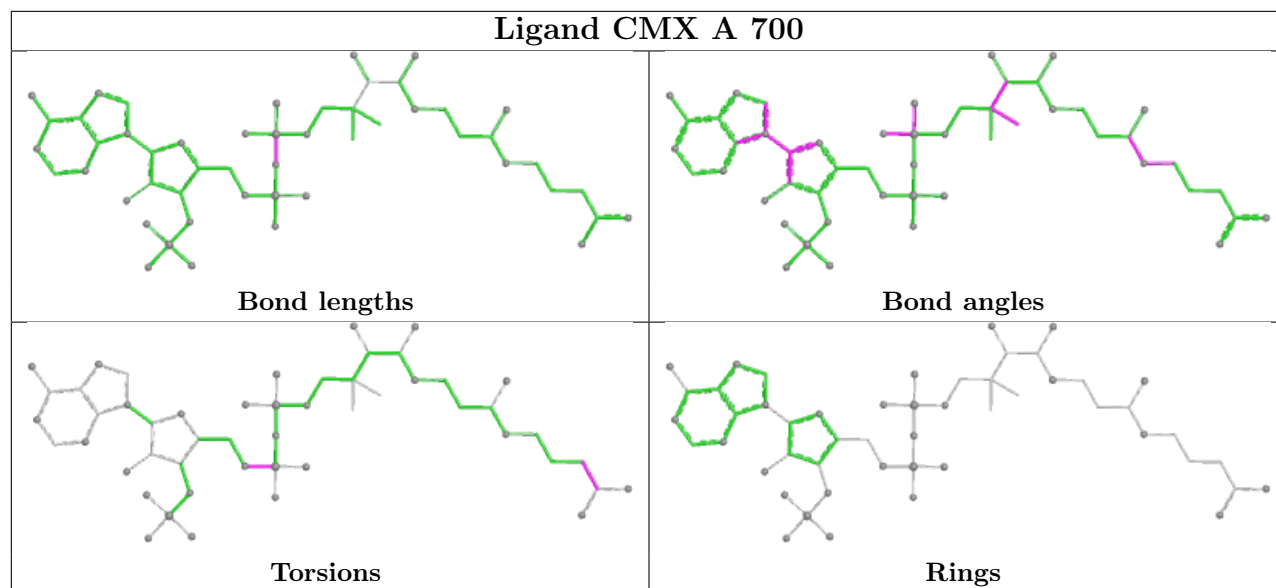
Mol	Chain	Res	Type	Atoms
3	A	700	CMX	C5B-O5B-P1A-O1A
3	A	700	CMX	C2P-C1-C2-O22
3	A	700	CMX	C2P-C1-C2-O21

There are no ring outliers.

1 monomer is involved in 3 short contacts:

Mol	Chain	Res	Type	Clashes	Symm-Clashes
3	A	700	CMX	3	0

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.



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.