



Full wwPDB X-ray Structure Validation Report ⓘ

Mar 9, 2026 – 08:11 AM UTC

PDB ID : 2FYC / pdb_00002fyc
Title : Crystal structure of the catalytic domain of bovine beta1,4-galactosyltransferase-I in complex with alpha-lactalbumin, Ca and UDP-galactose
Authors : Ramakrishnan, B.; Ramasamy, V.; Qasba, P.K.
Deposited on : 2006-02-07
Resolution : 2.00 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) : 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

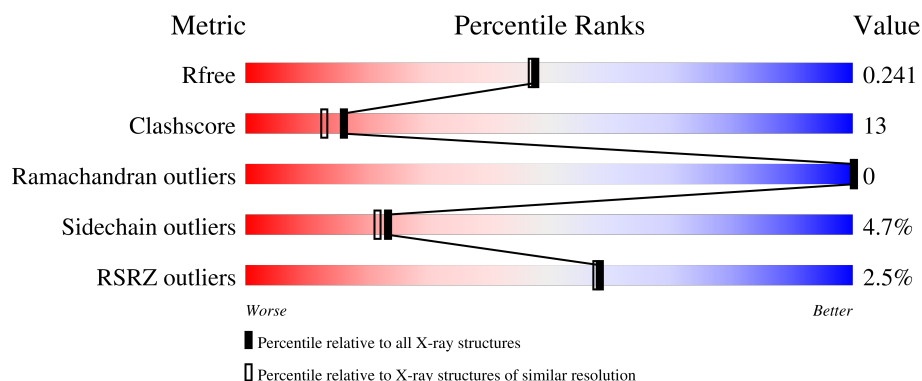
1 Overall quality at a glance

The following experimental techniques were used to determine the structure:

X-RAY DIFFRACTION

The reported resolution of this entry is 2.00 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	10052 (2.00-2.00)
Clashscore	190562	11152 (2.00-2.00)
Ramachandran outliers	187476	11031 (2.00-2.00)
Sidechain outliers	187428	11029 (2.00-2.00)
RSRZ outliers	180081	10067 (2.00-2.00)

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	123	5% 75% 21% ..
1	C	123	5% 74% 24% ..
2	B	286	% 68% 24% • 5%
2	D	286	% 67% 24% • 5%

2 Entry composition

There are 7 unique types of molecules in this entry. The entry contains 7305 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 Alpha-lactalbumin.

Mol	Chain	Residues	Atoms					ZeroOcc	AltConf	Trace
1	A	123	Total	C	N	O	S	0	0	0
			980	620	156	195	9			
1	C	123	Total	C	N	O	S	0	0	0
			980	620	156	195	9			

- Molecule 2 is a protein called beta-1,4-galactosyltransferase.

Mol	Chain	Residues	Atoms					ZeroOcc	AltConf	Trace
2	B	272	Total	C	N	O	S	0	0	0
			2221	1426	384	399	12			
2	D	272	Total	C	N	O	S	0	0	0
			2221	1426	384	399	12			

There are 30 discrepancies between the modelled and reference sequences:

Chain	Residue	Modelled	Actual	Comment	Reference
B	117	ALA	-	cloning artifact	UNP P08037
B	118	SER	-	cloning artifact	UNP P08037
B	119	MET	-	cloning artifact	UNP P08037
B	120	THR	-	cloning artifact	UNP P08037
B	121	GLY	-	cloning artifact	UNP P08037
B	122	GLY	-	cloning artifact	UNP P08037
B	123	GLN	-	cloning artifact	UNP P08037
B	124	GLN	-	cloning artifact	UNP P08037
B	125	MET	-	cloning artifact	UNP P08037
B	126	GLY	-	cloning artifact	UNP P08037
B	127	ARG	-	cloning artifact	UNP P08037
B	128	GLY	-	cloning artifact	UNP P08037
B	129	SER	-	cloning artifact	UNP P08037
B	342	THR	CYS	engineered mutation	UNP P08037
B	344	HIS	MET	engineered mutation	UNP P08037
D	117	ALA	-	cloning artifact	UNP P08037

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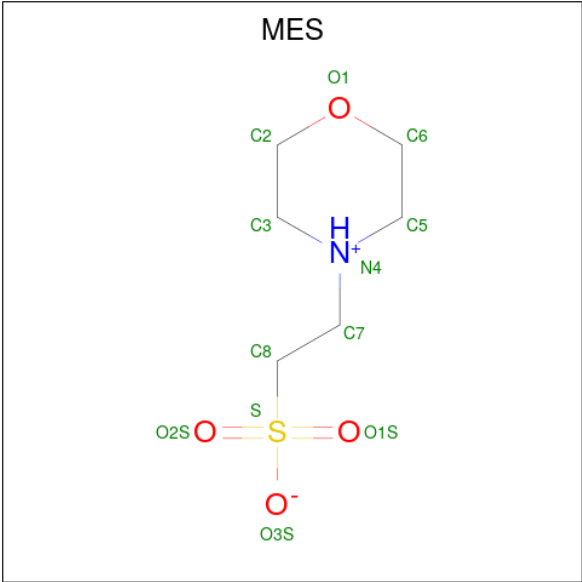
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Chain	Residue	Modelled	Actual	Comment	Reference
D	118	SER	-	cloning artifact	UNP P08037
D	119	MET	-	cloning artifact	UNP P08037
D	120	THR	-	cloning artifact	UNP P08037
D	121	GLY	-	cloning artifact	UNP P08037
D	122	GLY	-	cloning artifact	UNP P08037
D	123	GLN	-	cloning artifact	UNP P08037
D	124	GLN	-	cloning artifact	UNP P08037
D	125	MET	-	cloning artifact	UNP P08037
D	126	GLY	-	cloning artifact	UNP P08037
D	127	ARG	-	cloning artifact	UNP P08037
D	128	GLY	-	cloning artifact	UNP P08037
D	129	SER	-	cloning artifact	UNP P08037
D	342	THR	CYS	engineered mutation	UNP P08037
D	344	HIS	MET	engineered mutation	UNP P08037

- Molecule 3 is CALCIUM ION (CCD ID: CA) (formula: Ca).

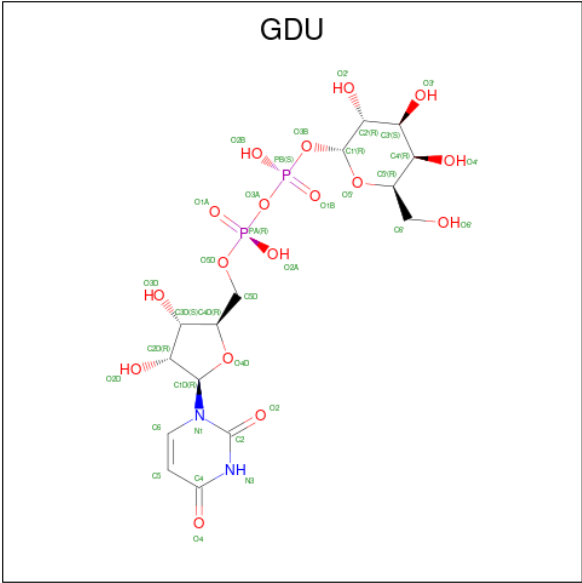
Mol	Chain	Residues	Atoms	ZeroOcc	AltConf
3	A	1	Total Ca 1 1	0	0
3	B	1	Total Ca 1 1	0	0
3	C	1	Total Ca 1 1	0	0
3	D	1	Total Ca 1 1	0	0

- Molecule 4 is 2-(N-MORPHOLINO)-ETHANESULFONIC ACID (CCD ID: MES) (formula: C₆H₁₃NO₄S).



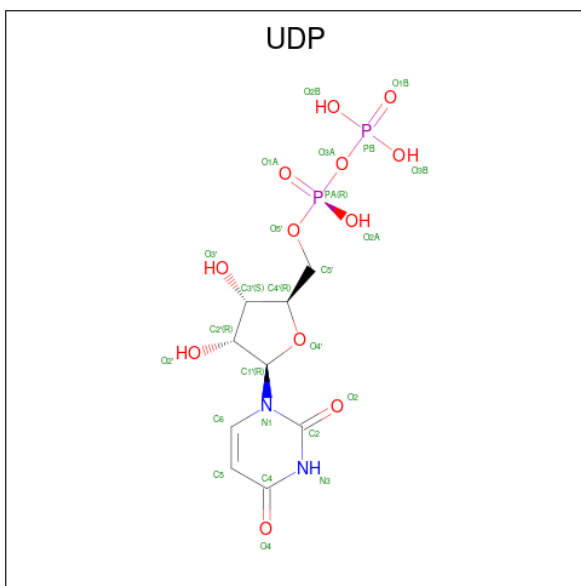
Mol	Chain	Residues	Atoms					ZeroOcc	AltConf
4	A	1	Total	C	N	O	S	0	0
			12	6	1	4	1		

- Molecule 5 is GALACTOSE-URIDINE-5'-DIPHOSPHATE (CCD ID: GDU) (formula: $C_{15}H_{24}N_2O_{17}P_2$).



Mol	Chain	Residues	Atoms					ZeroOcc	AltConf
5	B	1	Total	C	N	O	P	0	0
			36	15	2	17	2		
5	D	1	Total	C	N	O	P	0	0
			36	15	2	17	2		

- Molecule 6 is URIDINE-5'-DIPHOSPHATE (CCD ID: UDP) (formula: $\text{C}_9\text{H}_{14}\text{N}_2\text{O}_{12}\text{P}_2$).



Mol	Chain	Residues	Atoms					ZeroOcc	AltConf
6	B	1	Total 25	C 9	N 2	O 12	P 2	0	0
6	D	1	Total 25	C 9	N 2	O 12	P 2	0	0

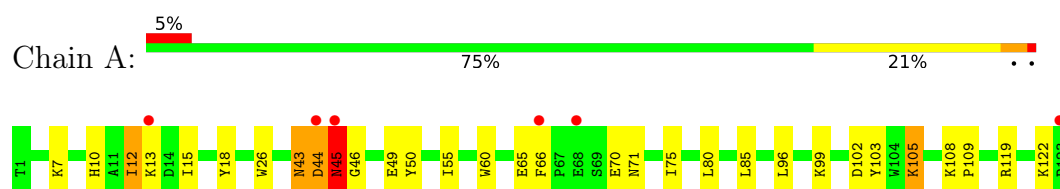
- Molecule 7 is water.

Mol	Chain	Residues	Atoms	ZeroOcc	AltConf
7	A	157	Total O 157 157	0	0
7	B	222	Total O 222 222	0	0
7	C	144	Total O 144 144	0	0
7	D	242	Total O 242 242	0	0

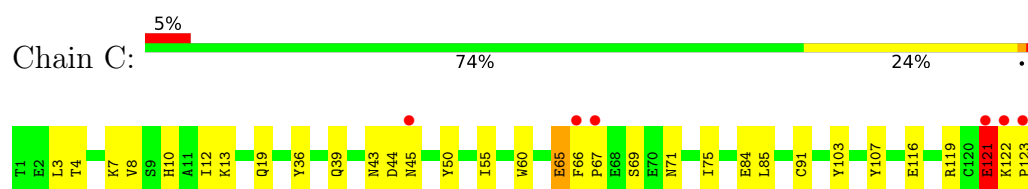
3 Residue-property plots [i](#)

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.

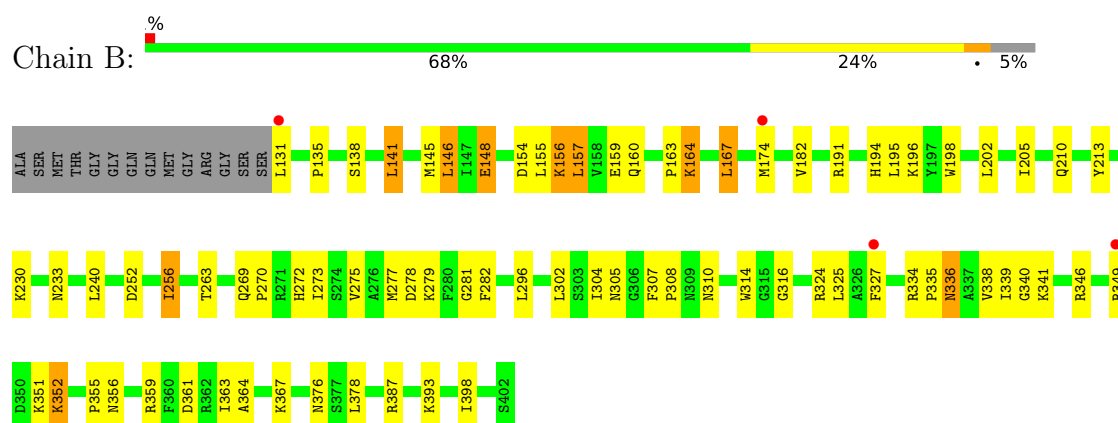
- Molecule 1: Alpha-lactalbumin



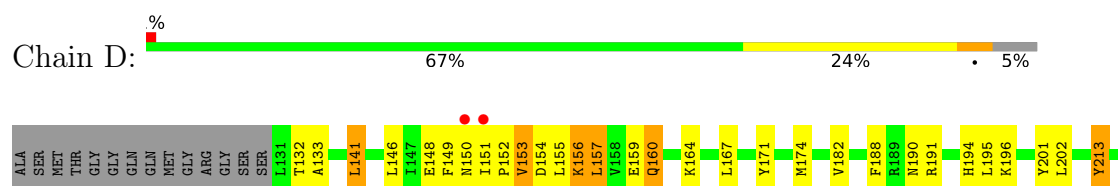
- Molecule 1: Alpha-lactalbumin

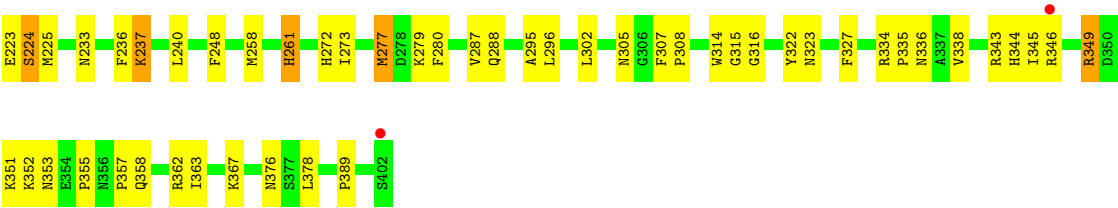


- Molecule 2: beta-1,4-galactosyltransferase



- Molecule 2: beta-1,4-galactosyltransferase





4 Data and refinement statistics

Property	Value	Source
Space group	P 1 21 1	Depositor
Cell constants a, b, c, α , β , γ	57.37Å 94.61Å 99.60Å 90.00° 101.78° 90.00°	Depositor
Resolution (Å)	32.56 – 2.00 32.56 – 2.00	Depositor EDS
% Data completeness (in resolution range)	96.2 (32.56-2.00) 96.2 (32.56-2.00)	Depositor EDS
R_{merge}	(Not available)	Depositor
R_{sym}	0.04	Depositor
$\langle I/\sigma(I) \rangle$ ¹	1.41 (at 1.98Å)	Xtriage
Refinement program	CNS 1.0	Depositor
R, R_{free}	0.200 , 0.246 0.196 , 0.241	Depositor DCC
R_{free} test set	6867 reflections (9.83%)	wwPDB-VP
Wilson B-factor (Å ²)	30.6	Xtriage
Anisotropy	0.352	Xtriage
Bulk solvent k_{sol} (e/Å ³), B_{sol} (Å ²)	0.34 , 49.4	EDS
L-test for twinning ²	$\langle L \rangle = 0.50$, $\langle L^2 \rangle = 0.33$	Xtriage
Estimated twinning fraction	No twinning to report.	Xtriage
F_o, F_c correlation	0.96	EDS
Total number of atoms	7305	wwPDB-VP
Average B, all atoms (Å ²)	36.0	wwPDB-VP

Xtriage's analysis on translational NCS is as follows: *The largest off-origin peak in the Patterson function is 5.19% 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

Bond lengths and bond angles in the following residue types are not validated in this section: MES, GDU, CA, UDP

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	0.69	0/1001	1.27	13/1350 (1.0%)
1	C	0.66	0/1001	1.15	9/1350 (0.7%)
2	B	0.63	1/2282 (0.0%)	1.05	11/3092 (0.4%)
2	D	0.66	1/2282 (0.0%)	1.07	13/3092 (0.4%)
All	All	0.65	2/6566 (0.0%)	1.11	46/8884 (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	1

All (2) bond length outliers are listed below:

Mol	Chain	Res	Type	Atoms	Z	Observed(Å)	Ideal(Å)
2	D	277	MET	SD-CE	-7.62	1.60	1.79
2	B	256	ILE	CA-CB	5.11	1.58	1.54

All (46) bond angle outliers are listed below:

Mol	Chain	Res	Type	Atoms	Z	Observed(°)	Ideal(°)
1	A	44	ASP	N-CA-C	-14.54	81.74	108.65
2	D	315	GLY	N-CA-C	10.29	124.94	112.48
1	A	44	ASP	CA-C-N	-9.14	107.92	122.73
1	A	44	ASP	C-N-CA	-9.14	107.92	122.73
1	A	60	TRP	N-CA-C	8.83	124.16	113.12
2	B	273	ILE	N-CA-C	8.59	119.44	111.45
1	A	46	GLY	N-CA-C	-8.58	104.47	114.69

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Mol	Chain	Res	Type	Atoms	Z	Observed(°)	Ideal(°)
2	D	273	ILE	N-CA-C	8.32	118.97	111.81
1	A	50	TYR	N-CA-C	8.10	122.59	109.40
1	C	50	TYR	N-CA-C	7.97	122.38	109.40
1	C	103	TYR	N-CA-C	-7.92	102.65	111.28
2	D	182	VAL	N-CA-C	7.66	118.89	108.17
1	C	121	GLU	N-CA-C	7.34	118.92	111.07
2	D	202	LEU	N-CA-C	7.23	119.25	111.36
2	B	182	VAL	N-CA-C	7.09	118.49	108.36
2	D	213	TYR	N-CA-C	7.09	120.65	109.81
2	B	213	TYR	N-CA-C	7.01	120.53	109.81
2	D	156	LYS	N-CA-C	-6.98	103.67	111.28
2	D	314	TRP	N-CA-C	6.96	121.20	110.20
1	A	45	ASN	N-CA-C	6.91	120.77	109.24
1	C	60	TRP	N-CA-C	6.86	121.92	112.04
1	A	12	ILE	N-CA-C	6.31	117.53	111.91
1	A	66	PHE	CA-C-N	6.29	125.98	119.56
1	A	66	PHE	C-N-CA	6.29	125.98	119.56
1	C	65	GLU	CA-C-N	-6.22	114.35	123.30
1	C	65	GLU	C-N-CA	-6.22	114.35	123.30
2	B	335	PRO	N-CA-C	-6.05	102.11	111.13
2	B	314	TRP	N-CA-C	5.98	118.93	110.50
2	D	188	PHE	N-CA-C	5.90	118.25	108.99
2	B	359	ARG	N-CA-C	5.89	117.70	111.28
2	B	202	LEU	N-CA-C	5.75	117.62	111.36
1	C	65	GLU	N-CA-C	5.64	119.89	112.89
2	D	224	SER	N-CA-C	-5.55	102.54	110.59
2	D	152	PRO	N-CA-C	-5.54	102.48	111.19
1	A	43	ASN	CA-C-N	5.40	129.29	122.16
1	A	43	ASN	C-N-CA	5.40	129.29	122.16
2	B	310	ASN	N-CA-C	5.39	119.49	113.02
2	D	261	HIS	N-CA-C	-5.37	106.69	113.18
2	B	252	ASP	N-CA-C	-5.35	102.96	110.50
2	D	335	PRO	N-CA-C	-5.33	103.19	111.13
2	D	201	TYR	N-CA-C	5.30	117.87	111.40
1	C	107	TYR	N-CA-C	5.30	117.49	111.02
1	C	19	GLN	N-CA-C	-5.27	106.43	112.86
1	A	70	GLU	N-CA-C	-5.13	105.69	111.28
2	B	356	ASN	CA-C-N	5.00	124.79	119.28
2	B	356	ASN	C-N-CA	5.00	124.79	119.28

There are no chirality outliers.

All (1) planarity outliers are listed below:

Mol	Chain	Res	Type	Group
1	A	45	ASN	Mainchain

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	980	0	936	24	0
1	C	980	0	936	25	0
2	B	2221	0	2185	58	0
2	D	2221	0	2185	65	0
3	A	1	0	0	0	0
3	B	1	0	0	0	0
3	C	1	0	0	0	0
3	D	1	0	0	0	0
4	A	12	0	13	5	0
5	B	36	0	22	0	0
5	D	36	0	22	0	0
6	B	25	0	11	0	0
6	D	25	0	11	1	0
7	A	157	0	0	2	0
7	B	222	0	0	7	0
7	C	144	0	0	5	0
7	D	242	0	0	5	0
All	All	7305	0	6321	169	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 (169) 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:71:ASN:HD21	1:A:75:ILE:H	1.20	0.90
2:D:349:ARG:HH11	2:D:349:ARG:HG2	1.36	0.89
2:D:236:PHE:O	2:D:240:LEU:HD23	1.73	0.88
1:A:43:ASN:HB3	1:A:44:ASP:O	1.75	0.86
2:B:156:LYS:HA	2:B:156:LYS:HE2	1.57	0.86
1:C:122:LYS:HD3	1:C:123:PRO:HD2	1.59	0.85

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Atom-1	Atom-2	Interatomic distance (Å)	Clash overlap (Å)
2:B:336:ASN:HD22	2:B:338:VAL:H	1.26	0.81
1:C:71:ASN:HD21	1:C:75:ILE:H	1.29	0.81
2:D:225:MET:HE2	2:D:352:LYS:HE3	1.63	0.79
2:B:327:PHE:CZ	2:B:367:LYS:HB2	2.21	0.75
2:B:191:ARG:HH11	2:B:194:HIS:HD2	1.32	0.75
2:D:132:THR:HG22	2:D:133:ALA:N	2.03	0.74
2:D:155:LEU:O	2:D:159:GLU:HG3	1.87	0.74
2:B:316:GLY:HA2	2:B:363:ILE:HD11	1.72	0.71
2:D:156:LYS:O	2:D:160:GLN:HG2	1.90	0.71
2:B:305:ASN:HD21	2:B:376:ASN:H	1.39	0.70
2:D:279:LYS:HB3	2:D:346:ARG:NH1	2.07	0.69
2:D:344:HIS:HD1	2:D:346:ARG:HD2	1.59	0.68
2:D:336:ASN:HD22	2:D:338:VAL:H	1.41	0.67
1:C:4:THR:HG23	1:C:7:LYS:HE2	1.77	0.66
2:D:225:MET:HE2	2:D:352:LYS:CE	2.26	0.65
2:D:277:MET:HE3	2:D:280:PHE:CD1	2.32	0.65
1:C:116:GLU:OE1	1:C:119:ARG:NH2	2.30	0.65
2:D:191:ARG:HH11	2:D:194:HIS:HD2	1.42	0.65
2:B:146:LEU:HD22	2:B:148:GLU:OE2	1.96	0.64
2:B:341:LYS:NZ	1:C:39:GLN:HE22	1.94	0.64
2:D:305:ASN:HD21	2:D:376:ASN:H	1.46	0.63
2:D:132:THR:CG2	2:D:133:ALA:N	2.62	0.63
2:D:279:LYS:HD2	2:D:346:ARG:HH12	1.65	0.62
1:C:66:PHE:HB2	7:C:1068:HOH:O	1.98	0.62
2:D:240:LEU:HD21	2:D:248:PHE:CZ	2.35	0.62
2:B:191:ARG:NH1	2:B:194:HIS:HD2	1.97	0.62
1:A:12:ILE:O	1:A:15:ILE:HG22	2.00	0.62
2:B:336:ASN:ND2	2:B:338:VAL:H	1.96	0.60
2:B:346:ARG:HG2	7:B:1571:HOH:O	2.01	0.59
2:D:164:LYS:N	2:D:164:LYS:HD3	2.17	0.59
1:C:122:LYS:HD3	1:C:123:PRO:CD	2.31	0.59
2:D:141:LEU:HD23	2:D:261:HIS:CD2	2.38	0.59
2:B:270:PRO:HB3	2:B:296:LEU:CD2	2.33	0.58
2:B:307:PHE:HB3	2:B:308:PRO:HD2	1.84	0.58
2:D:277:MET:HE3	2:D:280:PHE:HD1	1.68	0.58
2:B:164:LYS:HE2	7:B:1419:HOH:O	2.04	0.58
2:D:132:THR:CG2	2:D:133:ALA:H	2.17	0.57
1:C:121:GLU:HA	1:C:121:GLU:OE1	2.04	0.57
1:C:43:ASN:HB3	7:C:1627:HOH:O	2.04	0.56
2:B:270:PRO:HG2	2:B:325:LEU:HD22	1.86	0.56
2:B:270:PRO:CG	2:B:325:LEU:HD22	2.35	0.55

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Atom-1	Atom-2	Interatomic distance (Å)	Clash overlap (Å)
2:B:156:LYS:HA	2:B:156:LYS:CE	2.34	0.55
2:D:258:MET:SD	2:D:343:ARG:HG3	2.47	0.55
2:D:355:PRO:O	2:D:357:PRO:HD3	2.06	0.55
1:C:116:GLU:CD	1:C:119:ARG:NH2	2.64	0.55
2:B:275:VAL:HG22	2:B:340:GLY:HA3	1.88	0.55
2:D:344:HIS:ND1	2:D:346:ARG:NH1	2.55	0.54
1:C:116:GLU:OE2	1:C:119:ARG:NH2	2.37	0.54
2:D:160:GLN:HE21	2:D:160:GLN:HA	1.73	0.54
2:B:346:ARG:HB3	2:B:346:ARG:CZ	2.38	0.53
2:B:277:MET:CE	2:B:279:LYS:HE2	2.39	0.53
2:B:272:HIS:HB3	2:B:334:ARG:HG2	1.89	0.53
2:D:153:VAL:HG22	2:D:196:LYS:HB3	1.90	0.53
2:D:236:PHE:O	2:D:240:LEU:CD2	2.52	0.52
2:D:349:ARG:HH11	2:D:349:ARG:CG	2.13	0.52
2:B:156:LYS:HE2	2:B:156:LYS:CA	2.36	0.52
1:A:71:ASN:HD21	1:A:75:ILE:N	2.00	0.52
1:A:26:TRP:HZ2	1:A:96:LEU:HD11	1.73	0.52
1:A:43:ASN:ND2	1:A:45:ASN:OD1	2.42	0.52
2:D:272:HIS:HB3	2:D:334:ARG:HG2	1.92	0.51
2:B:277:MET:HE1	2:B:279:LYS:HE2	1.91	0.51
2:D:307:PHE:HB3	2:D:308:PRO:HD2	1.92	0.51
1:A:10:HIS:O	1:A:13:LYS:HG3	2.10	0.51
1:A:108:LYS:HB3	1:A:109:PRO:CD	2.41	0.51
2:B:131:LEU:N	2:B:131:LEU:HD23	2.25	0.51
2:B:196:LYS:HE2	7:B:1280:HOH:O	2.11	0.51
1:C:121:GLU:HG2	7:C:1599:HOH:O	2.09	0.51
2:D:349:ARG:HG2	2:D:349:ARG:NH1	2.15	0.51
2:D:349:ARG:HD2	2:D:353:ASN:O	2.11	0.51
2:D:164:LYS:HD3	2:D:164:LYS:H	1.74	0.51
2:D:174:MET:HE2	7:D:1409:HOH:O	2.11	0.50
1:C:55:ILE:HD13	1:C:91:CYS:SG	2.52	0.50
2:D:279:LYS:HD2	2:D:346:ARG:NH1	2.26	0.50
2:D:240:LEU:HD21	2:D:248:PHE:HZ	1.76	0.50
1:A:99:LYS:HD3	1:A:103:TYR:HB2	1.94	0.50
2:B:154:ASP:HB3	2:B:157:LEU:HD23	1.93	0.50
2:B:198:TRP:HA	2:B:256:ILE:HD11	1.94	0.49
1:C:10:HIS:HA	1:C:13:LYS:HE3	1.93	0.49
1:A:105:LYS:NZ	4:A:805:MES:H31	2.28	0.49
2:B:349:ARG:HH12	2:B:355:PRO:HD3	1.78	0.49
2:D:151:ILE:HG13	2:D:151:ILE:O	2.13	0.49
1:C:10:HIS:HB2	7:C:1583:HOH:O	2.12	0.49

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Atom-1	Atom-2	Interatomic distance (Å)	Clash overlap (Å)
2:D:154:ASP:HB3	2:D:157:LEU:HB2	1.94	0.49
2:B:338:VAL:O	2:B:341:LYS:HG3	2.13	0.49
1:A:102:ASP:HB2	7:A:1123:HOH:O	2.13	0.49
2:B:138:SER:HB3	2:B:141:LEU:HD13	1.95	0.49
2:D:336:ASN:ND2	2:D:338:VAL:HB	2.28	0.49
1:C:8:VAL:HG21	1:C:36:TYR:CD1	2.49	0.48
2:B:191:ARG:HD2	2:B:194:HIS:CD2	2.48	0.48
1:A:49:GLU:OE1	4:A:805:MES:H52	2.14	0.48
2:D:233:ASN:HB3	2:D:378:LEU:HD22	1.95	0.48
2:D:316:GLY:HA2	2:D:363:ILE:HD11	1.96	0.48
2:D:225:MET:HE2	2:D:352:LYS:NZ	2.28	0.48
2:B:336:ASN:HD22	2:B:336:ASN:C	2.22	0.48
2:D:153:VAL:CG2	2:D:196:LYS:HB3	2.43	0.48
2:D:132:THR:HG22	2:D:133:ALA:H	1.74	0.48
1:A:71:ASN:ND2	1:A:75:ILE:H	2.01	0.47
2:B:160:GLN:O	2:B:163:PRO:HD3	2.14	0.47
2:D:194:HIS:HE1	7:D:1345:HOH:O	1.95	0.47
2:D:237:LYS:HE2	7:D:1435:HOH:O	2.15	0.47
2:B:316:GLY:CA	2:B:363:ILE:HD11	2.43	0.47
2:D:191:ARG:HD2	2:D:194:HIS:CD2	2.50	0.47
2:D:288:GLN:HA	2:D:322:TYR:CE1	2.50	0.47
2:D:148:GLU:OE2	2:D:148:GLU:HA	2.14	0.47
2:D:191:ARG:NH1	2:D:194:HIS:HD2	2.10	0.47
1:A:105:LYS:HE2	7:B:1540:HOH:O	2.15	0.46
2:D:171:TYR:HB3	2:D:213:TYR:CE2	2.50	0.46
2:D:362:ARG:NH2	7:D:1205:HOH:O	2.45	0.46
2:D:351:LYS:HB2	2:D:351:LYS:HE2	1.80	0.46
2:B:341:LYS:HZ1	1:C:39:GLN:HE22	1.59	0.46
2:B:361:ASP:HB3	7:B:1297:HOH:O	2.15	0.45
1:A:105:LYS:HZ2	4:A:805:MES:H31	1.81	0.45
1:C:10:HIS:CD2	1:C:13:LYS:NZ	2.84	0.45
2:B:167:LEU:HD13	2:B:387:ARG:HB3	1.97	0.45
1:C:65:GLU:O	1:C:67:PRO:HD3	2.16	0.45
2:B:393:LYS:HD2	7:B:1180:HOH:O	2.16	0.45
2:D:295:ALA:C	2:D:296:LEU:HD12	2.42	0.45
2:B:351:LYS:O	2:B:352:LYS:HB2	2.15	0.45
2:B:233:ASN:HB3	2:B:378:LEU:HD22	1.99	0.45
2:B:191:ARG:NH1	2:B:194:HIS:CD2	2.82	0.45
1:A:108:LYS:HB3	1:A:109:PRO:HD3	1.98	0.45
2:B:154:ASP:OD1	2:B:156:LYS:HB2	2.17	0.45
2:B:270:PRO:HB3	2:B:296:LEU:HD21	1.99	0.45

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Atom-1	Atom-2	Interatomic distance (Å)	Clash overlap (Å)
2:B:279:LYS:NZ	7:B:1556:HOH:O	2.47	0.44
1:C:10:HIS:O	1:C:13:LYS:HG3	2.17	0.44
1:C:66:PHE:HB3	1:C:69:SER:HB2	1.99	0.44
1:A:109:PRO:HB3	2:B:364:ALA:HB2	1.99	0.44
1:C:8:VAL:O	1:C:12:ILE:HG12	2.17	0.44
1:A:105:LYS:HG3	4:A:805:MES:H31	2.00	0.44
2:D:240:LEU:CD2	2:D:248:PHE:CZ	3.01	0.44
2:B:145:MET:HE1	2:B:205:ILE:CD1	2.48	0.44
2:D:149:PHE:CZ	2:D:345:ILE:HG12	2.53	0.44
2:B:336:ASN:HD22	2:B:338:VAL:N	2.04	0.43
1:A:10:HIS:HE1	1:A:122:LYS:O	2.01	0.43
2:B:336:ASN:ND2	2:B:339:ILE:H	2.15	0.43
2:D:277:MET:HE2	7:D:1187:HOH:O	2.18	0.43
2:D:344:HIS:HD1	2:D:346:ARG:NH1	2.17	0.43
1:A:103:TYR:CE2	4:A:805:MES:H51	2.54	0.43
1:A:55:ILE:HB	1:A:80:LEU:HD13	2.01	0.43
2:D:146:LEU:HG	2:D:148:GLU:HG2	2.01	0.42
2:B:135:PRO:HD2	2:B:210:GLN:HE22	1.85	0.42
1:C:44:ASP:HB3	1:C:45:ASN:H	1.70	0.42
2:D:316:GLY:CA	2:D:363:ILE:HD11	2.50	0.42
2:D:323:ASN:HD21	2:D:363:ILE:HG23	1.85	0.42
2:D:336:ASN:HD21	2:D:338:VAL:HB	1.84	0.42
2:B:155:LEU:HA	2:B:155:LEU:HD23	1.80	0.42
2:B:304:ILE:HB	2:B:324:ARG:HB3	2.02	0.42
2:B:269:GLN:O	2:B:270:PRO:C	2.63	0.41
2:D:327:PHE:CE2	2:D:367:LYS:HD2	2.55	0.41
2:D:279:LYS:CD	2:D:346:ARG:HH12	2.31	0.41
1:A:18:TYR:HB3	7:A:1030:HOH:O	2.20	0.41
2:B:278:ASP:HB3	2:B:282:PHE:CZ	2.56	0.41
1:C:3:LEU:HA	1:C:7:LYS:HE3	2.02	0.41
2:B:281:GLY:O	2:B:282:PHE:HB2	2.21	0.41
1:A:65:GLU:O	1:A:65:GLU:HG2	2.20	0.41
2:B:164:LYS:HG2	2:B:174:MET:HE3	2.03	0.41
2:B:351:LYS:HD3	2:B:351:LYS:HA	1.87	0.41
2:B:230:LYS:HD3	2:B:398:ILE:HB	2.02	0.40
1:A:119:ARG:HG3	1:A:119:ARG:HH21	1.85	0.40
2:B:155:LEU:O	2:B:159:GLU:HG3	2.22	0.40
1:C:119:ARG:NH1	7:C:1440:HOH:O	2.53	0.40
2:D:389:PRO:HD2	6:D:529:UDP:C4	2.57	0.40
2:D:358:GLN:O	2:D:362:ARG:HG3	2.21	0.40

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	121/123 (98%)	117 (97%)	4 (3%)	0	100	100
1	C	121/123 (98%)	117 (97%)	4 (3%)	0	100	100
2	B	270/286 (94%)	262 (97%)	8 (3%)	0	100	100
2	D	270/286 (94%)	261 (97%)	9 (3%)	0	100	100
All	All	782/818 (96%)	757 (97%)	25 (3%)	0	100	100

There are no Ramachandran outliers to report.

5.3.2 Protein sidechains

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	109/109 (100%)	106 (97%)	3 (3%)	38	41
1	C	109/109 (100%)	106 (97%)	3 (3%)	38	41
2	B	245/254 (96%)	232 (95%)	13 (5%)	20	18
2	D	245/254 (96%)	231 (94%)	14 (6%)	18	15
All	All	708/726 (98%)	675 (95%)	33 (5%)	23	22

All (33) residues with a non-rotameric sidechain are listed below:

Mol	Chain	Res	Type
1	A	7	LYS
1	A	85	LEU

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Mol	Chain	Res	Type
1	A	105	LYS
2	B	141	LEU
2	B	146	LEU
2	B	148	GLU
2	B	156	LYS
2	B	157	LEU
2	B	164	LYS
2	B	167	LEU
2	B	195	LEU
2	B	240	LEU
2	B	263	THR
2	B	302	LEU
2	B	336	ASN
2	B	352	LYS
1	C	84	GLU
1	C	85	LEU
1	C	121	GLU
2	D	141	LEU
2	D	150	ASN
2	D	153	VAL
2	D	157	LEU
2	D	160	GLN
2	D	167	LEU
2	D	190	ASN
2	D	195	LEU
2	D	223	GLU
2	D	224	SER
2	D	237	LYS
2	D	287	VAL
2	D	302	LEU
2	D	349	ARG

Sometimes sidechains can be flipped to improve hydrogen bonding and reduce clashes. All (20) such sidechains are listed below:

Mol	Chain	Res	Type
1	A	10	HIS
1	A	71	ASN
2	B	150	ASN
2	B	160	GLN
2	B	161	GLN
2	B	194	HIS
2	B	210	GLN

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Mol	Chain	Res	Type
2	B	219	ASN
2	B	299	GLN
2	B	305	ASN
2	B	310	ASN
2	B	336	ASN
1	C	39	GLN
1	C	71	ASN
2	D	150	ASN
2	D	160	GLN
2	D	161	GLN
2	D	194	HIS
2	D	305	ASN
2	D	336	ASN

5.3.3 RNA [i](#)

There are no RNA molecules in this entry.

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 [i](#)

Of 9 ligands modelled in this entry, 4 are monoatomic - leaving 5 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	$\# Z > 2$
5	GDU	B	403	3	37,38,38	1.50	5 (13%)	55,58,58	1.61	10 (18%)

Mol	Type	Chain	Res	Link	Bond lengths			Bond angles		
					Counts	RMSZ	# Z > 2	Counts	RMSZ	# Z > 2
6	UDP	B	405	-	25,26,26	1.90	3 (12%)	38,40,40	1.46	8 (21%)
4	MES	A	805	-	12,12,12	1.19	1 (8%)	15,16,16	0.93	0
5	GDU	D	528	3	37,38,38	1.57	5 (13%)	55,58,58	1.59	8 (14%)
6	UDP	D	529	-	25,26,26	2.00	3 (12%)	38,40,40	1.51	6 (15%)

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
5	GDU	B	403	3	-	9/23/59/59	0/3/3/3
6	UDP	B	405	-	-	0/16/32/32	0/2/2/2
4	MES	A	805	-	-	2/6/14/14	0/1/1/1
5	GDU	D	528	3	-	7/23/59/59	0/3/3/3
6	UDP	D	529	-	-	5/16/32/32	0/2/2/2

All (17) bond length outliers are listed below:

Mol	Chain	Res	Type	Atoms	Z	Observed(Å)	Ideal(Å)
6	D	529	UDP	PA-O3A	7.36	1.67	1.59
6	B	405	UDP	PA-O3A	7.33	1.67	1.59
5	D	528	GDU	PA-O3A	5.35	1.65	1.59
5	B	403	GDU	PA-O3A	5.15	1.65	1.59
6	D	529	UDP	PB-O1B	3.77	1.62	1.50
5	D	528	GDU	PB-O3B	-3.52	1.48	1.59
6	B	405	UDP	PB-O1B	3.41	1.61	1.50
5	D	528	GDU	O5'-C5'	3.00	1.51	1.44
6	D	529	UDP	C2-N1	2.97	1.43	1.38
5	B	403	GDU	PB-O3B	-2.56	1.51	1.59
5	B	403	GDU	PB-O3A	-2.40	1.56	1.59
4	A	805	MES	C5-N4	2.28	1.53	1.46
6	B	405	UDP	C2-N1	2.25	1.42	1.38
5	B	403	GDU	O5'-C1'	2.20	1.47	1.41
5	B	403	GDU	O5'-C5'	2.20	1.49	1.44
5	D	528	GDU	C4-N3	2.07	1.42	1.38
5	D	528	GDU	O5'-C1'	2.05	1.47	1.41

All (32) bond angle outliers are listed below:

Mol	Chain	Res	Type	Atoms	Z	Observed(°)	Ideal(°)
5	B	403	GDU	O3B-PB-O1B	5.47	127.30	109.81
5	D	528	GDU	O3B-PB-O1B	4.80	125.16	109.81
5	B	403	GDU	O5'-C5'-C6'	-4.20	96.03	106.44
6	D	529	UDP	O5'-C5'-C4'	4.18	123.24	108.99
5	D	528	GDU	O5'-C5'-C6'	-4.12	96.22	106.44
5	D	528	GDU	O5'-C1'-O3B	3.95	116.53	111.36
6	D	529	UDP	O3B-PB-O1B	3.89	125.99	110.83
6	B	405	UDP	O3B-PB-O1B	3.68	125.18	110.83
6	B	405	UDP	O5'-C5'-C4'	3.39	120.52	108.99
5	B	403	GDU	O3A-PB-O1B	-3.36	100.58	110.70
5	D	528	GDU	O4D-C4D-C3D	-3.26	98.68	105.15
5	B	403	GDU	O4D-C4D-C3D	-3.25	98.70	105.15
5	B	403	GDU	O5'-C1'-O3B	3.00	115.28	111.36
5	D	528	GDU	O3A-PB-O1B	-2.93	101.89	110.70
5	D	528	GDU	O2-C2-N1	-2.90	119.03	122.80
6	D	529	UDP	C2'-C1'-N1	2.89	121.30	113.25
5	B	403	GDU	O2-C2-N1	-2.81	119.14	122.80
6	B	405	UDP	O4'-C4'-C3'	-2.70	99.79	105.15
5	D	528	GDU	O3'-C3'-C4'	-2.67	104.09	110.38
6	B	405	UDP	O2-C2-N1	-2.66	119.34	122.80
6	B	405	UDP	C2'-C1'-N1	2.53	120.28	113.25
6	D	529	UDP	O2-C2-N1	-2.50	119.55	122.80
5	B	403	GDU	C6'-C5'-C4'	2.41	118.94	113.02
6	B	405	UDP	O2-C2-N3	2.40	125.92	121.49
5	D	528	GDU	O2-C2-N3	2.35	125.82	121.49
6	B	405	UDP	O3A-PB-O1B	-2.30	98.95	111.04
5	B	403	GDU	O2-C2-N3	2.29	125.72	121.49
6	D	529	UDP	O2-C2-N3	2.19	125.52	121.49
6	D	529	UDP	O3A-PB-O1B	-2.09	100.02	111.04
5	B	403	GDU	O3'-C3'-C4'	-2.07	105.49	110.38
5	B	403	GDU	O5D-C5D-C4D	2.07	116.03	108.99
6	B	405	UDP	O3B-PB-O3A	2.07	111.56	104.64

There are no chirality outliers.

All (23) torsion outliers are listed below:

Mol	Chain	Res	Type	Atoms
4	A	805	MES	C8-C7-N4-C3
4	A	805	MES	C8-C7-N4-C5
5	B	403	GDU	C1'-O3B-PB-O3A
5	B	403	GDU	C1'-O3B-PB-O1B
5	D	528	GDU	C1'-O3B-PB-O3A
6	D	529	UDP	C5'-O5'-PA-O1A

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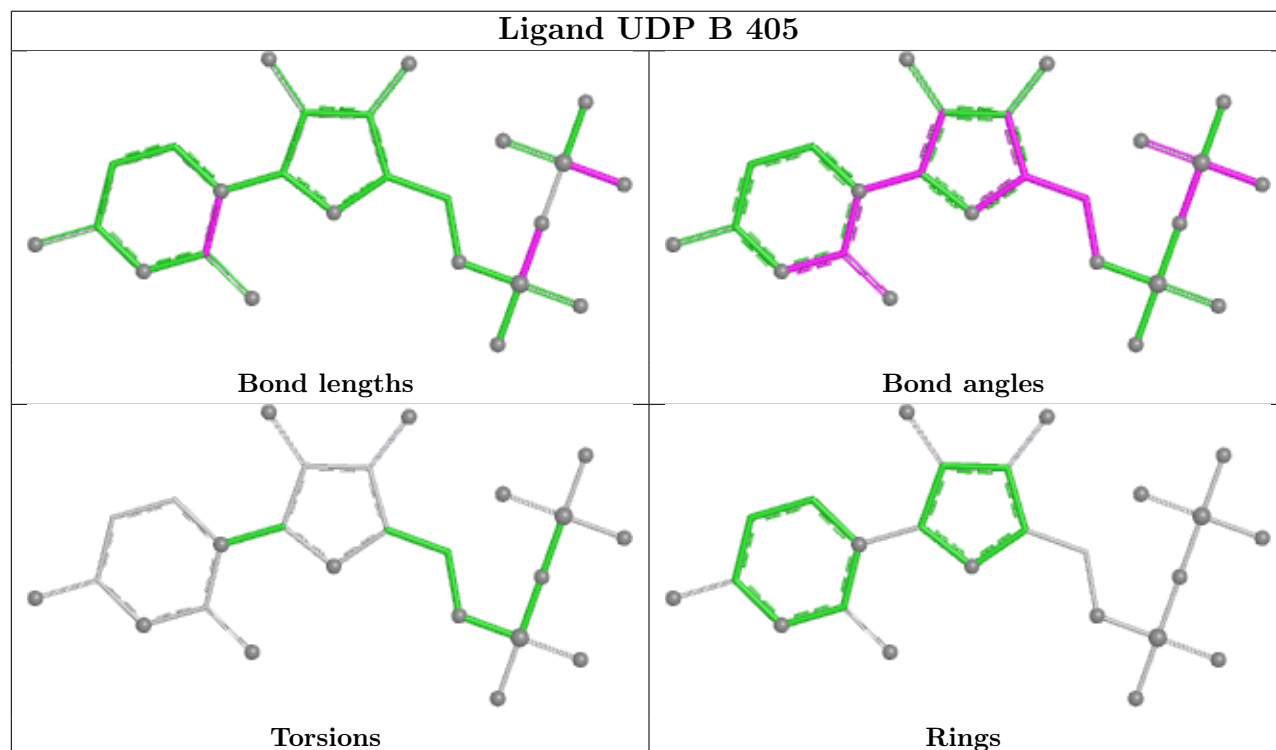
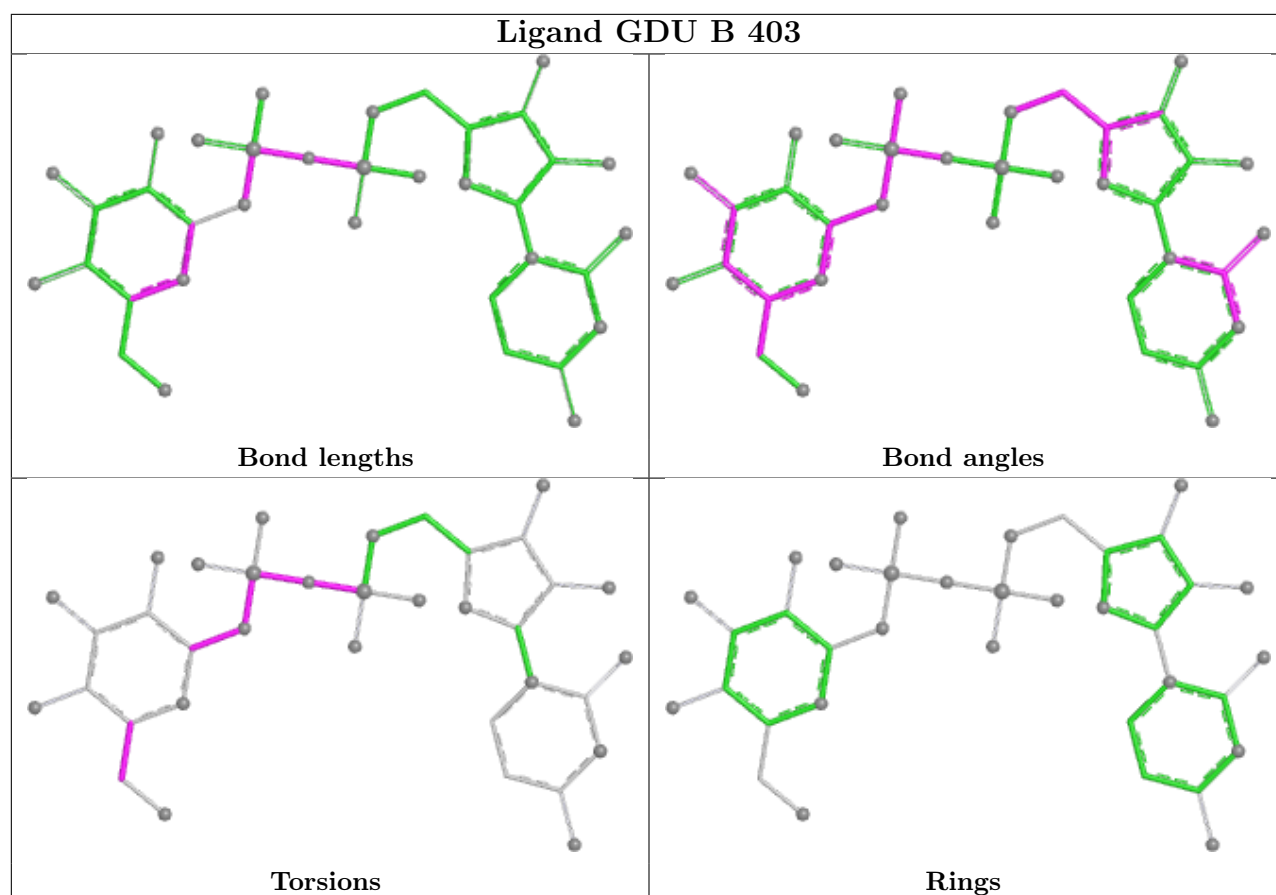
Mol	Chain	Res	Type	Atoms
6	D	529	UDP	C5'-O5'-PA-O2A
6	D	529	UDP	C5'-O5'-PA-O3A
5	D	528	GDU	C2'-C1'-O3B-PB
5	B	403	GDU	O5'-C5'-C6'-O6'
6	D	529	UDP	C3'-C4'-C5'-O5'
5	B	403	GDU	C4'-C5'-C6'-O6'
5	D	528	GDU	O5'-C5'-C6'-O6'
5	D	528	GDU	C1'-O3B-PB-O1B
5	B	403	GDU	PB-O3A-PA-O1A
5	B	403	GDU	C2'-C1'-O3B-PB
6	D	529	UDP	O4'-C4'-C5'-O5'
5	D	528	GDU	PA-O3A-PB-O2B
5	B	403	GDU	PA-O3A-PB-O2B
5	B	403	GDU	PA-O3A-PB-O1B
5	D	528	GDU	PB-O3A-PA-O2A
5	D	528	GDU	PA-O3A-PB-O1B
5	B	403	GDU	PB-O3A-PA-O2A

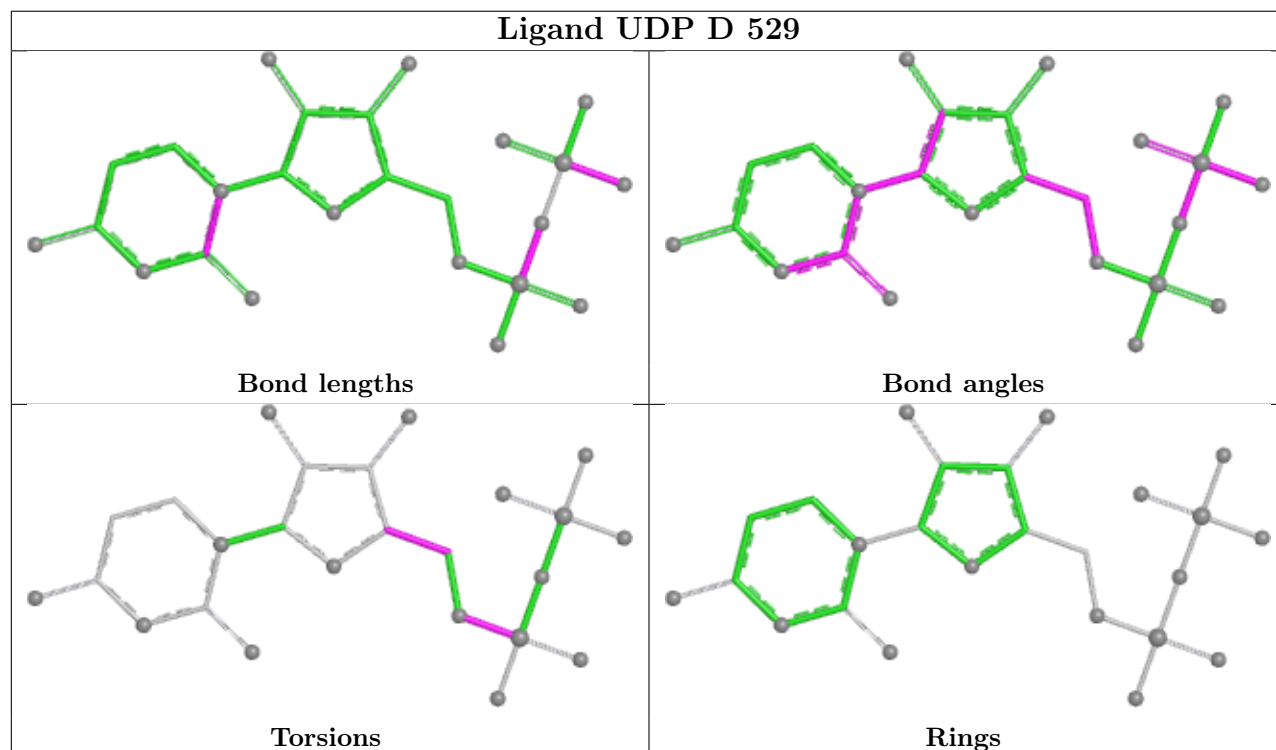
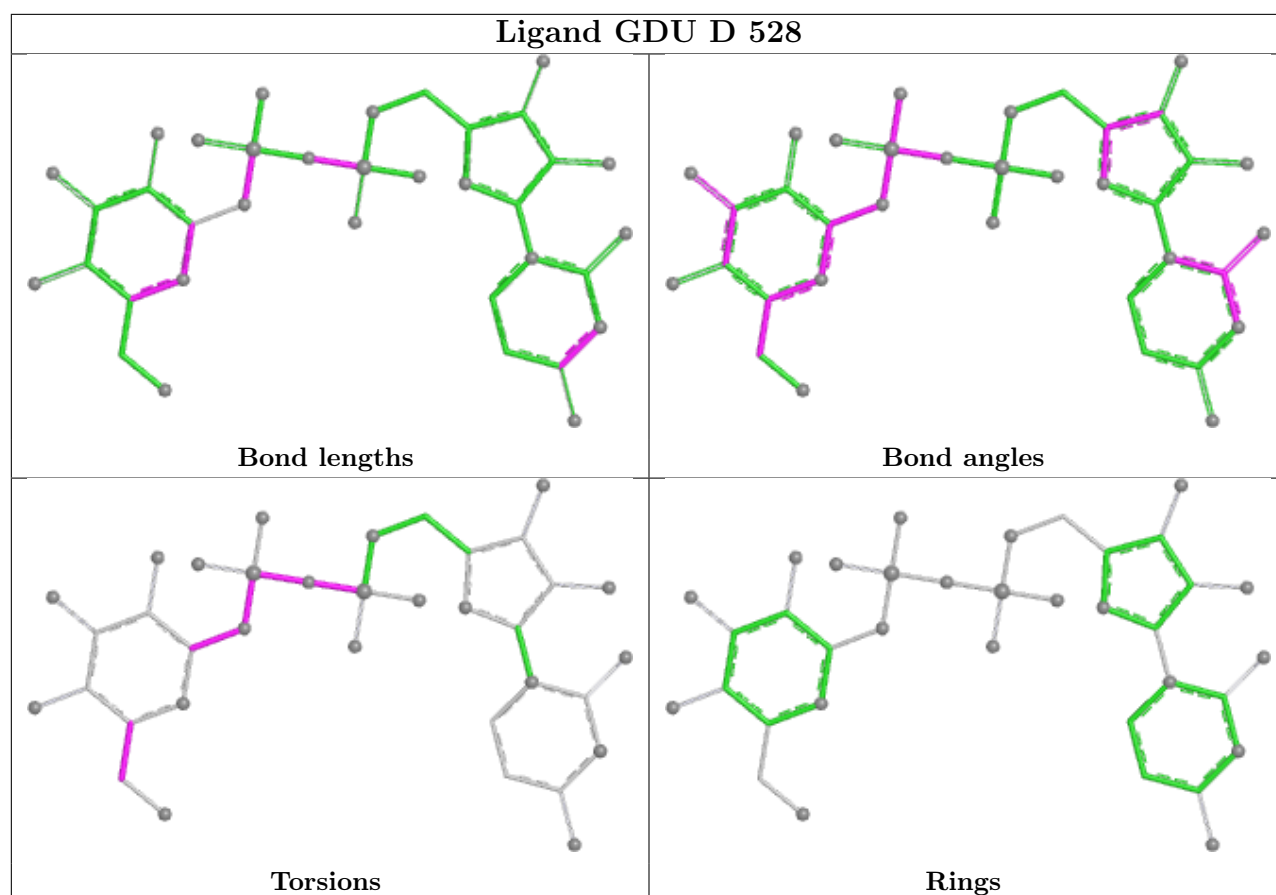
There are no ring outliers.

2 monomers are involved in 6 short contacts:

Mol	Chain	Res	Type	Clashes	Symm-Clashes
4	A	805	MES	5	0
6	D	529	UDP	1	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

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	123/123 (100%)	0.07	6 (4%) 35 34	20, 31, 59, 67	0
1	C	123/123 (100%)	0.04	6 (4%) 35 34	21, 31, 52, 85	0
2	B	272/286 (95%)	0.01	4 (1%) 72 71	22, 33, 57, 67	0
2	D	272/286 (95%)	-0.08	4 (1%) 72 71	21, 32, 51, 65	0
All	All	790/818 (96%)	-0.01	20 (2%) 58 58	20, 32, 56, 85	0

All (20) RSRZ outliers are listed below:

Mol	Chain	Res	Type	RSRZ
1	A	44	ASP	4.4
1	A	123	PRO	3.9
2	D	151	ILE	3.9
1	C	123	PRO	3.6
1	C	121	GLU	3.5
2	D	346	ARG	3.4
1	A	45	ASN	2.9
1	C	66	PHE	2.7
1	C	122	LYS	2.7
1	C	45	ASN	2.6
1	A	66	PHE	2.6
1	C	67	PRO	2.4
2	B	131	LEU	2.4
1	A	68	GLU	2.3
2	B	174	MET	2.3
2	D	402	SER	2.3
2	D	150	ASN	2.2
2	B	327	PHE	2.1
2	B	349	ARG	2.1
1	A	13	LYS	2.0

6.2 Non-standard residues in protein, DNA, RNA chains ⓘ

There are no non-standard protein/DNA/RNA residues in this entry.

6.3 Carbohydrates ⓘ

There are no oligosaccharides in this entry.

6.4 Ligands ⓘ

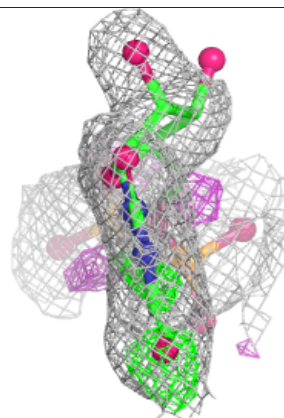
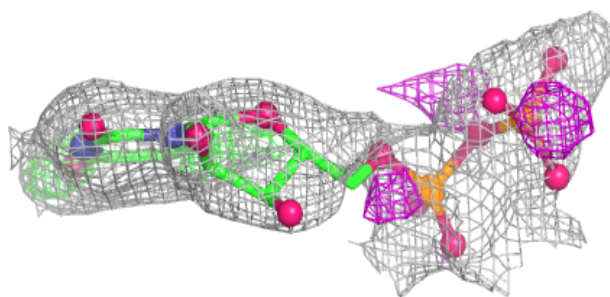
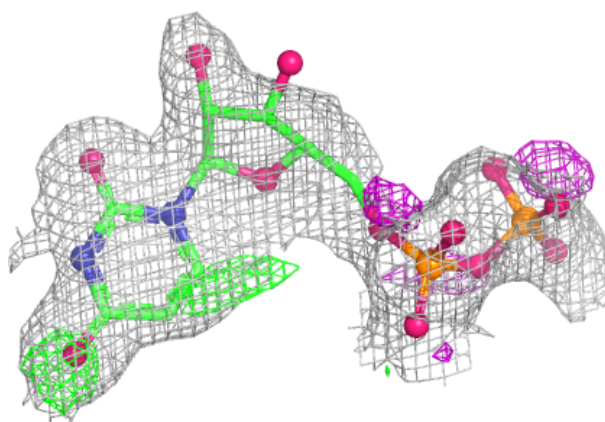
In the following table, the Atoms column lists the number of modelled atoms in the group and the number defined in the chemical component dictionary. The B-factors column lists the minimum, median, 95th percentile and maximum values of B factors of atoms in the group. The column labelled 'Q< 0.9' lists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

Mol	Type	Chain	Res	Atoms	RSCC	RSR	B-factors($\text{\AA}^2$)	Q<0.9
6	UDP	D	529	25/25	0.71	0.16	65,80,96,96	0
6	UDP	B	405	25/25	0.77	0.16	70,81,93,94	0
4	MES	A	805	12/12	0.84	0.17	53,55,62,62	0
5	GDU	B	403	36/36	0.96	0.07	24,28,32,35	0
5	GDU	D	528	36/36	0.97	0.06	23,26,30,30	0
3	CA	C	526	1/1	0.98	0.04	33,33,33,33	0
3	CA	A	124	1/1	0.99	0.02	23,23,23,23	0
3	CA	B	404	1/1	0.99	0.02	34,34,34,34	0
3	CA	D	527	1/1	1.00	0.01	29,29,29,29	0

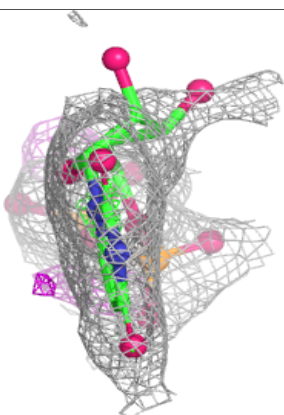
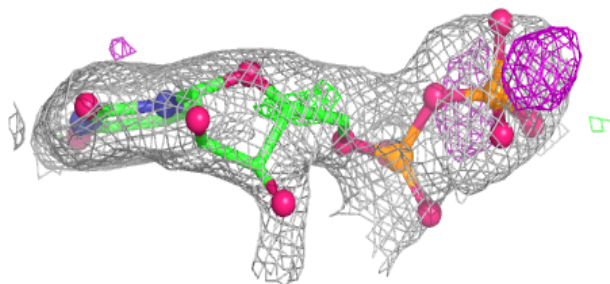
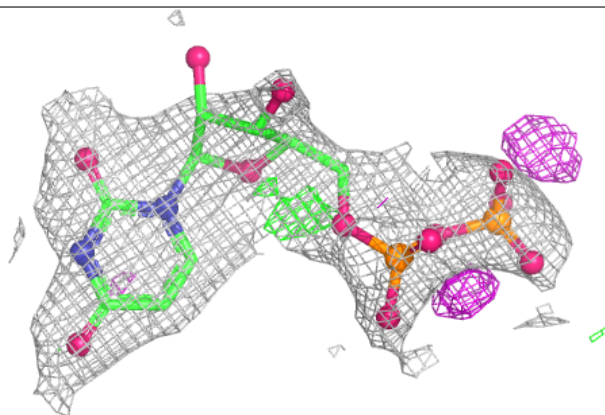
The following is a graphical depiction of the model fit to experimental electron density of all instances of the Ligand of Interest. In addition, ligands with molecular weight > 250 and outliers as shown on the geometry validation Tables will also be included. Each fit is shown from different orientation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

Electron density around UDP D 529:

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

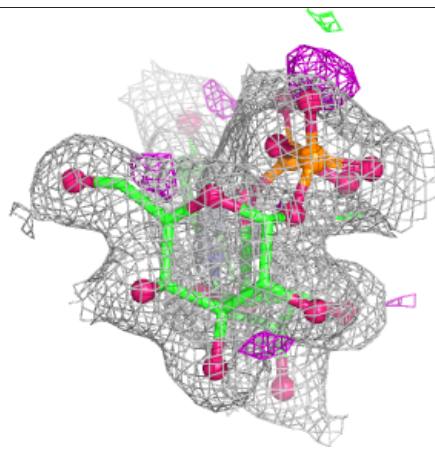
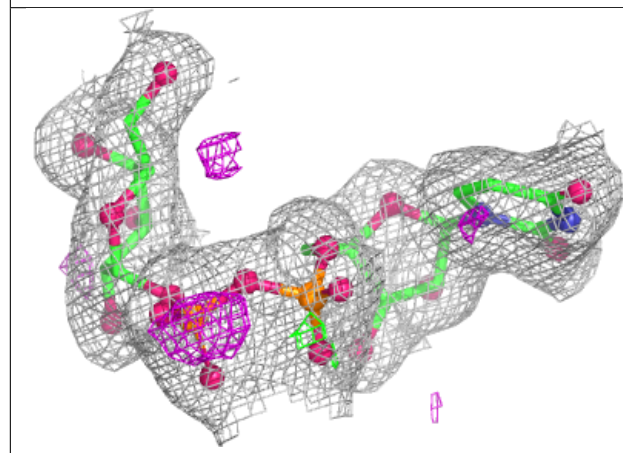
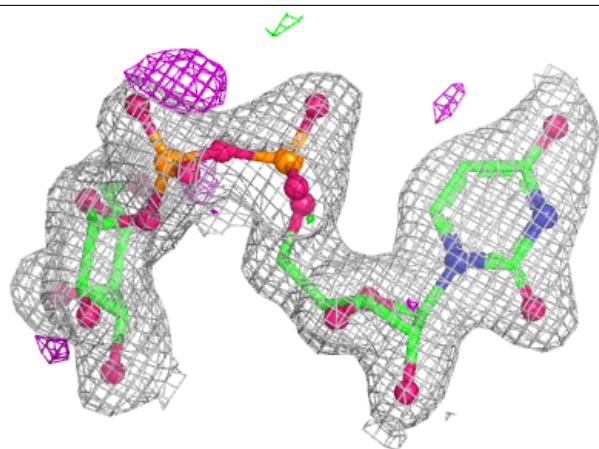
**Electron density around UDP B 405:**

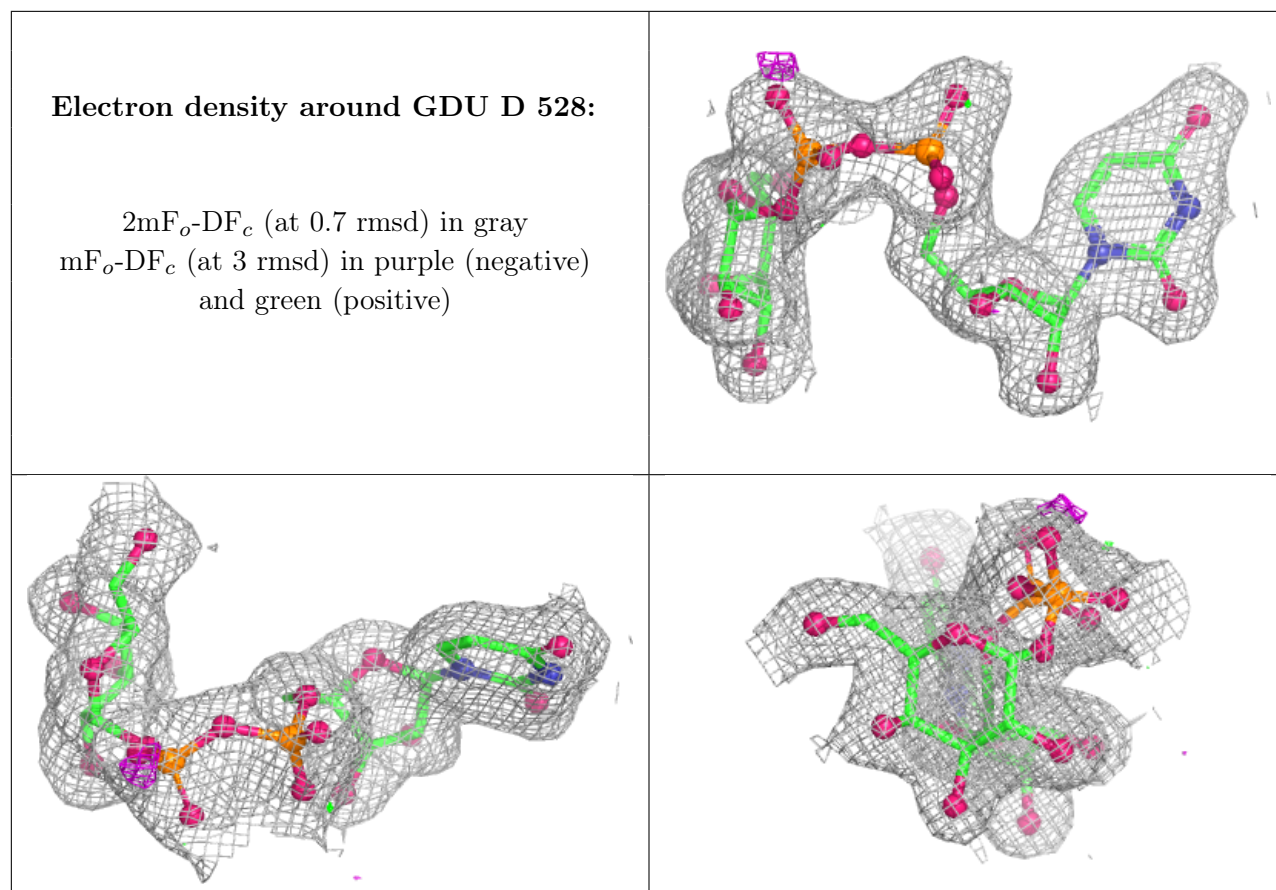
$2mF_o-DF_c$ (at 0.7 rmsd) in gray
 mF_o-DF_c (at 3 rmsd) in purple (negative)
and green (positive)



Electron density around GDU B 403:

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





6.5 Other polymers ⓘ

There are no such residues in this entry.