



Full wwPDB X-ray Structure Validation Report ⓘ

Mar 17, 2026 – 09:57 PM UTC

PDB ID : 6KPR / pdb_00006kpr
Title : Quadruple mutant (N51I+C59R+S108N+I164L) plasmodium falciparum dihydrofolate reductase-thymidylate synthase (PfDHFR-TS) complexed with B12155 inhibitor
Authors : Vanichtanankul, J.; Vitsupakorn, D.
Deposited on : 2019-08-15
Resolution : 2.10 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

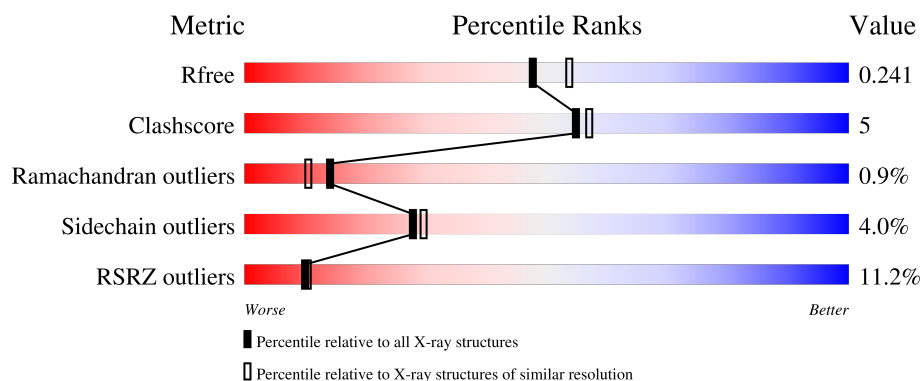
1 Overall quality at a glance

The following experimental techniques were used to determine the structure:

X-RAY DIFFRACTION

The reported resolution of this entry is 2.10 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	6658 (2.10-2.10)
Clashscore	190562	7164 (2.10-2.10)
Ramachandran outliers	187476	7099 (2.10-2.10)
Sidechain outliers	187428	7100 (2.10-2.10)
RSRZ outliers	180081	6662 (2.10-2.10)

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	608	5% 76% 10% • 12%
1	B	608	15% 74% 12% • 12%

2 Entry composition [i](#)

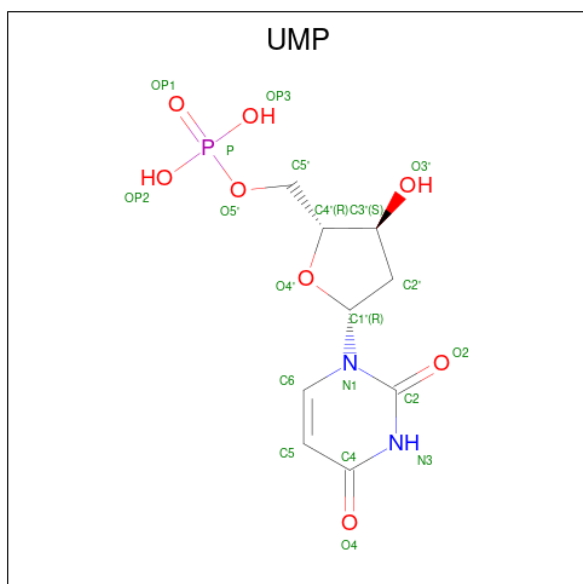
There are 6 unique types of molecules in this entry. The entry contains 9438 atoms, of which 0 are hydrogens and 0 are deuteriums.

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 Bifunctional dihydrofolate reductase-thymidylate synthase.

Mol	Chain	Residues	Atoms					ZeroOcc	AltConf	Trace
1	A	534	Total	C	N	O	S	0	0	0
			4450	2878	736	811	25			
1	B	534	Total	C	N	O	S	0	0	0
			4444	2873	733	814	24			

- Molecule 2 is 2'-DEOXYURIDINE 5'-MONOPHOSPHATE (CCD ID: UMP) (formula: $C_9H_{13}N_2O_8P$).



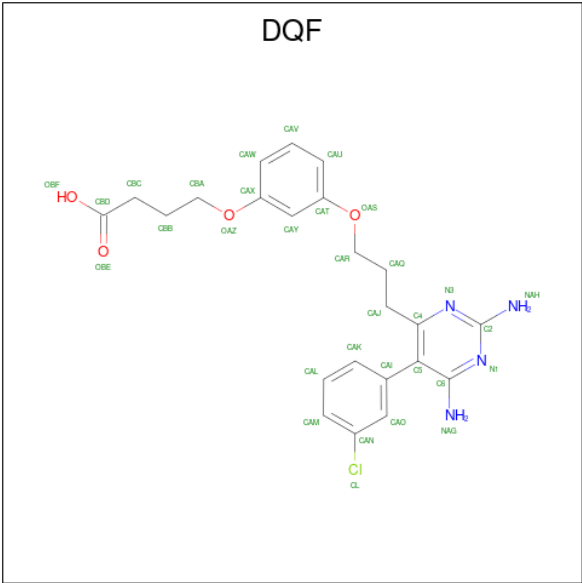
Mol	Chain	Residues	Atoms					ZeroOcc	AltConf
2	A	1	Total	C	N	O	P	0	0
			20	9	2	8	1		
2	B	1	Total	C	N	O	P	0	0
			20	9	2	8	1		

- Molecule 3 is NADPH DIHYDRO-NICOTINAMIDE-ADENINE-DINUCLEOTIDE PHOSPHATE (CCD ID: NDP) (formula: $C_{21}H_{30}N_7O_{17}P_3$).



Mol	Chain	Residues	Atoms					ZeroOcc	AltConf
3	A	1	Total	C	N	O	P	0	0
			48	21	7	17	3		
3	B	1	Total	C	N	O	P	0	0
			48	21	7	17	3		

- Molecule 4 is 4-[3-[3-[2,6-bis(azanyl)-5-(3-chlorophenyl)pyrimidin-4-yl]propoxy]phenoxy]butanoic acid (CCD ID: DQF) (formula: C₂₃H₂₅ClN₄O₄) (labeled as "Ligand of Interest" by depositor).



Mol	Chain	Residues	Atoms					ZeroOcc	AltConf
4	A	1	Total	C	Cl	N	O	0	0
			32	23	1	4	4		

Continued on next page...

Continued from previous page...

Mol	Chain	Residues	Atoms				ZeroOcc	AltConf
4	B	1	Total	C	Cl	N	O	
			32	23	1	4	4	
							0	0

- Molecule 5 is GLYCEROL (CCD ID: GOL) (formula: $C_3H_8O_3$).



Mol	Chain	Residues	Atoms			ZeroOcc	AltConf
5	A	1	Total	C	O		
			6	3	3		
						0	0
5	B	1	Total	C	O		
			6	3	3		
						0	0

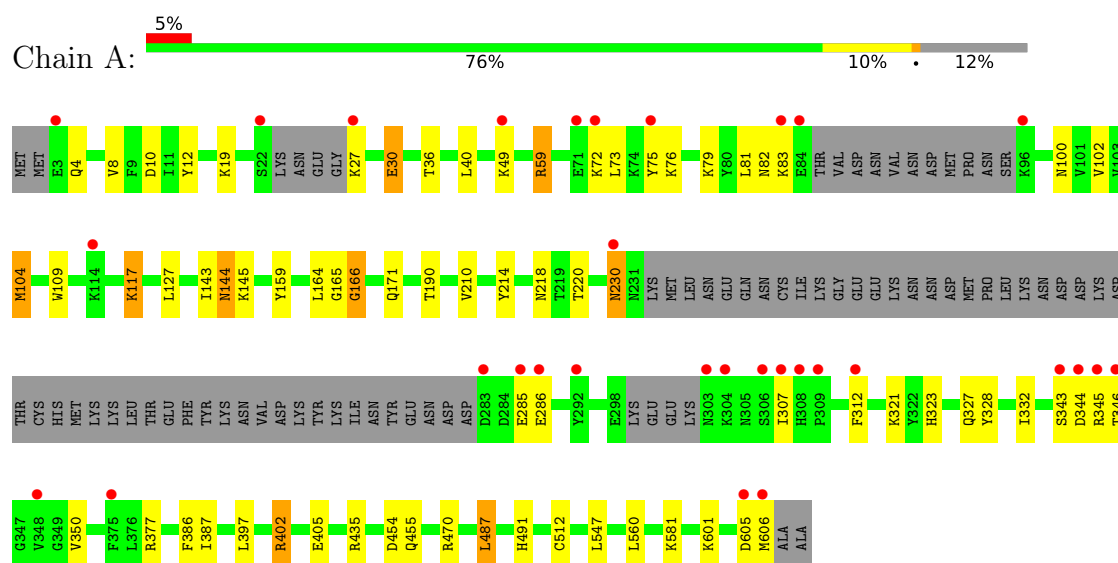
- Molecule 6 is water.

Mol	Chain	Residues	Atoms		ZeroOcc	AltConf
6	A	170	Total	O		
			170	170		
					0	0
6	B	162	Total	O		
			162	162		
					0	0

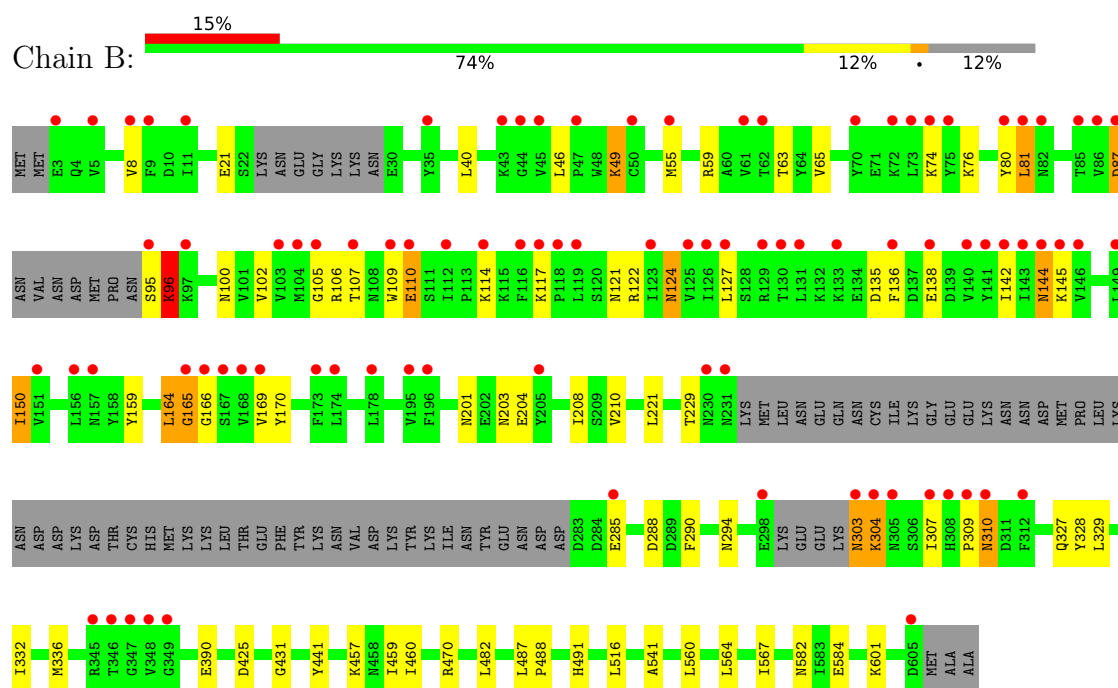
3 Residue-property plots [i](#)

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: Bifunctional dihydrofolate reductase-thymidylate synthase



- Molecule 1: Bifunctional dihydrofolate reductase-thymidylate synthase



4 Data and refinement statistics

Property	Value	Source
Space group	P 21 21 21	Depositor
Cell constants a, b, c, α , β , γ	57.90Å 156.50Å 165.48Å 90.00° 90.00° 90.00°	Depositor
Resolution (Å)	26.99 – 2.10 26.99 – 2.10	Depositor EDS
% Data completeness (in resolution range)	97.2 (26.99-2.10) 97.4 (26.99-2.10)	Depositor EDS
R_{merge}	0.06	Depositor
R_{sym}	(Not available)	Depositor
$\langle I/\sigma(I) \rangle$ ¹	3.60 (at 2.10Å)	Xtriage
Refinement program	REFMAC 5.8.0253	Depositor
R, R_{free}	0.195 , 0.241 (Not available) , 0.241	Depositor DCC
R_{free} test set	4377 reflections (4.91%)	wwPDB-VP
Wilson B-factor (Å ²)	24.3	Xtriage
Anisotropy	0.024	Xtriage
Bulk solvent k_{sol} (e/Å ³), B_{sol} (Å ²)	0.34 , 35.8	EDS
L-test for twinning ²	$\langle L \rangle = 0.51$, $\langle L^2 \rangle = 0.35$	Xtriage
Estimated twinning fraction	No twinning to report.	Xtriage
F_o, F_c correlation	0.95	EDS
Total number of atoms	9438	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 3.75% 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: UMP, NDP, DQF, GOL

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	1.07	2/4553 (0.0%)	1.33	12/6146 (0.2%)
1	B	1.09	3/4547 (0.1%)	1.36	5/6142 (0.1%)
All	All	1.08	5/9100 (0.1%)	1.34	17/12288 (0.1%)

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	3
1	B	0	1
All	All	0	4

All (5) bond length outliers are listed below:

Mol	Chain	Res	Type	Atoms	Z	Observed(Å)	Ideal(Å)
1	B	431	GLY	C-O	5.90	1.30	1.23
1	B	541	ALA	CA-C	5.30	1.55	1.52
1	B	390	GLU	C-O	5.26	1.30	1.23
1	A	454	ASP	C-O	5.12	1.29	1.23
1	A	323	HIS	CE1-NE2	5.09	1.37	1.32

All (17) bond angle outliers are listed below:

Mol	Chain	Res	Type	Atoms	Z	Observed(°)	Ideal(°)
1	B	327	GLN	CB-CG-CD	-6.30	101.89	112.60
1	A	455	GLN	CB-CA-C	-6.06	100.72	110.79
1	A	104	MET	CA-C-N	6.00	125.80	120.10
1	A	104	MET	C-N-CA	6.00	125.80	120.10

Continued on next page...

Continued from previous page...

Mol	Chain	Res	Type	Atoms	Z	Observed(°)	Ideal(°)
1	A	59	ARG	CG-CD-NE	-5.93	98.95	112.00
1	A	386	PHE	CA-CB-CG	5.84	119.64	113.80
1	A	30	GLU	CB-CA-C	5.77	119.31	109.72
1	B	164	LEU	CA-C-N	5.55	126.69	120.42
1	B	164	LEU	C-N-CA	5.55	126.69	120.42
1	A	117	LYS	CB-CA-C	-5.51	101.98	109.42
1	A	327	GLN	CB-CG-CD	-5.37	103.47	112.60
1	A	377	ARG	CA-C-N	5.28	125.80	119.94
1	A	377	ARG	C-N-CA	5.28	125.80	119.94
1	B	567	ILE	CA-C-O	5.23	123.02	119.20
1	A	323	HIS	CB-CA-C	5.19	117.76	109.62
1	B	304	LYS	N-CA-C	-5.16	105.55	111.07
1	A	190	THR	CA-CB-OG1	-5.14	101.89	109.60

There are no chirality outliers.

All (4) planarity outliers are listed below:

Mol	Chain	Res	Type	Group
1	A	165	GLY	Mainchain,Peptide
1	A	350	VAL	Peptide
1	B	165	GLY	Peptide

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	4450	0	4405	39	0
1	B	4444	0	4389	49	0
2	A	20	0	11	1	0
2	B	20	0	11	1	0
3	A	48	0	26	3	0
3	B	48	0	26	4	0
4	A	32	0	0	0	0
4	B	32	0	0	1	0
5	A	6	0	8	0	0
5	B	6	0	8	0	0
6	A	170	0	0	5	0

Continued on next page...

Continued from previous page...

Mol	Chain	Non-H	H(model)	H(added)	Clashes	Symm-Clashes
6	B	162	0	0	5	0
All	All	9438	0	8884	87	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 5.

All (87) 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:166:GLY:HA3	3:A:702:NDP:PA	2.20	0.82
1:A:166:GLY:HA3	3:A:702:NDP:O1A	1.82	0.79
1:B:109:TRP:CZ2	1:B:117:LYS:HD2	2.25	0.72
1:B:328:TYR:CZ	1:B:332:ILE:HD11	2.24	0.72
1:B:304:LYS:H	1:B:304:LYS:CD	2.03	0.71
1:B:584:GLU:HG3	6:B:873:HOH:O	1.90	0.71
1:A:328:TYR:CZ	1:A:332:ILE:HD11	2.31	0.66
1:A:210:VAL:HB	6:A:947:HOH:O	1.96	0.65
1:B:210:VAL:HB	6:B:842:HOH:O	1.96	0.64
1:A:109:TRP:CZ2	1:A:117:LYS:HD2	2.33	0.64
1:B:102:VAL:HB	1:B:164:LEU:HD11	1.82	0.61
1:A:8:VAL:HA	1:A:76:LYS:HD2	1.81	0.61
1:B:122:ARG:O	1:B:124:ASN:ND2	2.34	0.61
1:B:336:MET:HE1	1:B:560:LEU:HB2	1.83	0.60
1:B:165:GLY:HA3	1:B:170:TYR:CZ	2.37	0.59
1:B:288:ASP:OD1	6:B:801:HOH:O	2.17	0.59
1:B:304:LYS:H	1:B:304:LYS:HD2	1.69	0.56
1:B:59:ARG:O	1:B:63:THR:HG23	2.07	0.53
1:B:144:ASN:O	3:B:702:NDP:H2A	2.08	0.53
1:A:307:ILE:HG21	1:A:312:PHE:HE2	1.74	0.53
1:B:329:LEU:HD22	1:B:564:LEU:HD12	1.91	0.52
1:B:166:GLY:HA3	3:B:702:NDP:PA	2.50	0.52
1:A:144:ASN:C	1:A:144:ASN:HD22	2.19	0.51
1:B:80:TYR:CD2	1:B:81:LEU:HD13	2.45	0.51
1:B:87:ASP:OD1	1:B:87:ASP:N	2.44	0.50
1:A:344:ASP:OD2	1:A:346:THR:HG23	2.11	0.50
1:A:491:HIS:CE1	2:A:701:UMP:O4	2.65	0.50
1:B:109:TRP:CE2	1:B:117:LYS:HD2	2.47	0.49
1:B:65:VAL:HG22	1:B:159:TYR:CB	2.42	0.49
1:B:136:PHE:CD2	1:B:142:ILE:HD11	2.48	0.49
1:A:343:SER:HA	6:A:805:HOH:O	2.13	0.48
1:B:303:ASN:OD1	1:B:307:ILE:O	2.31	0.48

Continued on next page...

Continued from previous page...

Atom-1	Atom-2	Interatomic distance (Å)	Clash overlap (Å)
1:B:8:VAL:HA	1:B:76:LYS:CD	2.43	0.48
1:A:102:VAL:HB	1:A:164:LEU:HD11	1.96	0.48
1:A:387:ILE:O	1:A:435:ARG:NH1	2.44	0.48
1:A:344:ASP:C	1:A:346:THR:H	2.22	0.48
1:B:221:LEU:N	1:B:221:LEU:HD23	2.27	0.48
1:B:8:VAL:HA	1:B:76:LYS:HD3	1.95	0.47
1:A:605:ASP:O	1:A:606:MET:C	2.57	0.47
1:A:100:ASN:OD1	1:A:159:TYR:HB3	2.15	0.47
1:A:4:GLN:O	1:A:8:VAL:HG23	2.16	0.46
1:B:304:LYS:H	1:B:304:LYS:HD3	1.78	0.46
1:B:124:ASN:N	1:B:124:ASN:HD22	2.14	0.46
1:A:40:LEU:O	3:A:702:NDP:H2N	2.17	0.45
1:A:581:LYS:HA	1:A:581:LYS:HD3	1.81	0.45
1:B:100:ASN:OD1	1:B:159:TYR:HB3	2.16	0.45
6:A:867:HOH:O	1:B:470:ARG:HD3	2.15	0.45
1:A:470:ARG:HD3	6:B:880:HOH:O	2.16	0.45
1:B:95:SER:O	1:B:96:LYS:HG2	2.17	0.45
1:A:332:ILE:HD13	1:A:560:LEU:HD22	1.99	0.45
1:B:165:GLY:HA3	1:B:170:TYR:CE2	2.52	0.45
1:B:290:PHE:CE2	1:B:294:ASN:ND2	2.85	0.44
1:B:491:HIS:CE1	2:B:701:UMP:O4	2.70	0.44
1:A:344:ASP:O	1:A:346:THR:N	2.51	0.44
1:A:10:ASP:OD2	1:A:73:LEU:HD22	2.17	0.44
1:A:19:LYS:HG2	1:A:36:THR:HG22	1.99	0.44
1:A:81:LEU:HB3	1:A:83:LYS:HE2	2.00	0.44
1:A:214:TYR:O	1:A:220:THR:HA	2.18	0.43
1:A:230:ASN:H	1:A:230:ASN:HD22	1.65	0.43
1:A:402:ARG:NH1	1:A:405:GLU:OE1	2.51	0.43
1:A:109:TRP:CE2	1:A:117:LYS:HD2	2.53	0.42
1:A:127:LEU:HD23	1:A:143:ILE:HG13	2.01	0.42
1:A:321:LYS:HE3	6:A:916:HOH:O	2.19	0.42
1:A:487:LEU:N	1:A:487:LEU:CD2	2.82	0.42
1:B:81:LEU:HD12	1:B:81:LEU:HA	1.93	0.42
1:B:582:ASN:HB3	6:B:873:HOH:O	2.19	0.42
1:B:95:SER:O	1:B:96:LYS:CG	2.68	0.42
1:A:397:LEU:HD23	1:A:397:LEU:HA	1.90	0.42
1:A:75:TYR:CE2	1:A:79:LYS:HD2	2.55	0.42
1:B:46:LEU:N	4:B:703:DQF:OBE	2.43	0.42
1:B:201:ASN:HB3	1:B:204:GLU:HB2	2.01	0.42
1:A:12:TYR:OH	1:B:285:GLU:OE2	2.37	0.42
1:A:307:ILE:CG2	1:A:312:PHE:HE2	2.31	0.42

Continued on next page...

Continued from previous page...

Atom-1	Atom-2	Interatomic distance (Å)	Clash overlap (Å)
1:B:106:ARG:NH1	1:B:110:GLU:OE1	2.54	0.41
1:B:166:GLY:HA3	3:B:702:NDP:O1A	2.19	0.41
1:B:459:ILE:HG13	1:B:460:ILE:N	2.35	0.41
1:B:487:LEU:N	1:B:487:LEU:HD23	2.36	0.41
1:B:425:ASP:OD1	1:B:441:TYR:OH	2.38	0.41
1:B:482:LEU:HD22	1:B:488:PRO:HB3	2.03	0.41
1:B:150:ILE:N	1:B:150:ILE:HD13	2.36	0.41
1:A:344:ASP:C	1:A:346:THR:N	2.77	0.41
1:A:512:CYS:SG	1:A:547:LEU:HD22	2.61	0.41
1:B:40:LEU:O	3:B:702:NDP:H2N	2.21	0.41
1:B:328:TYR:CZ	1:B:332:ILE:CD1	3.00	0.41
1:A:321:LYS:CE	6:A:916:HOH:O	2.68	0.40
1:B:105:GLY:N	1:B:169:VAL:HG21	2.36	0.40
1:B:303:ASN:HD22	1:B:303:ASN:N	2.20	0.40

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	524/608 (86%)	497 (95%)	23 (4%)	4 (1%)	16	12
1	B	524/608 (86%)	492 (94%)	27 (5%)	5 (1%)	12	9
All	All	1048/1216 (86%)	989 (94%)	50 (5%)	9 (1%)	14	10

All (9) Ramachandran outliers are listed below:

Mol	Chain	Res	Type
1	A	345	ARG
1	B	49	LYS
1	A	166	GLY
1	B	96	LYS

Continued on next page...

Continued from previous page...

Mol	Chain	Res	Type
1	A	82	ASN
1	A	601	LYS
1	B	310	ASN
1	B	121	ASN
1	B	309	PRO

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	500/570 (88%)	485 (97%)	15 (3%)	36	41
1	B	500/570 (88%)	475 (95%)	25 (5%)	22	22
All	All	1000/1140 (88%)	960 (96%)	40 (4%)	28	29

All (40) residues with a non-rotameric sidechain are listed below:

Mol	Chain	Res	Type
1	A	27	LYS
1	A	30	GLU
1	A	49	LYS
1	A	59	ARG
1	A	72	LYS
1	A	104	MET
1	A	144	ASN
1	A	145	LYS
1	A	171	GLN
1	A	218	ASN
1	A	230	ASN
1	A	285	GLU
1	A	286	GLU
1	A	402	ARG
1	A	487	LEU
1	B	21	GLU
1	B	49	LYS
1	B	55	MET

Continued on next page...

Continued from previous page...

Mol	Chain	Res	Type
1	B	74	LYS
1	B	81	LEU
1	B	87	ASP
1	B	96	LYS
1	B	107	THR
1	B	110	GLU
1	B	114	LYS
1	B	124	ASN
1	B	127	LEU
1	B	135	ASP
1	B	138	GLU
1	B	144	ASN
1	B	145	LYS
1	B	150	ILE
1	B	203	ASN
1	B	208	ILE
1	B	229	THR
1	B	303	ASN
1	B	310	ASN
1	B	457	LYS
1	B	516	LEU
1	B	601	LYS

Sometimes sidechains can be flipped to improve hydrogen bonding and reduce clashes. All (16) such sidechains are listed below:

Mol	Chain	Res	Type
1	A	42	ASN
1	A	99	GLN
1	A	121	ASN
1	A	144	ASN
1	A	201	ASN
1	A	230	ASN
1	A	303	ASN
1	A	394	ASN
1	A	407	ASN
1	A	415	ASN
1	A	424	ASN
1	B	231	ASN
1	B	294	ASN
1	B	303	ASN
1	B	340	ASN
1	B	394	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](#)

8 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	$\# Z > 2$
4	DQF	A	703	-	34,34,34	1.59	5 (14%)	45,45,45	2.72	16 (35%)
3	NDP	B	702	-	51,52,52	1.95	17 (33%)	71,80,80	1.79	16 (22%)
5	GOL	A	704	-	5,5,5	0.19	0	5,5,5	0.33	0
5	GOL	B	704	-	5,5,5	0.12	0	5,5,5	0.45	0
2	UMP	A	701	-	21,21,21	0.68	0	30,31,31	1.03	1 (3%)
4	DQF	B	703	-	34,34,34	1.33	3 (8%)	45,45,45	2.46	15 (33%)
2	UMP	B	701	-	21,21,21	0.89	1 (4%)	30,31,31	1.01	2 (6%)
3	NDP	A	702	-	51,52,52	1.88	17 (33%)	71,80,80	1.78	16 (22%)

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	DQF	A	703	-	-	9/18/18/18	0/3/3/3

Continued on next page...

Continued from previous page...

Mol	Type	Chain	Res	Link	Chirals	Torsions	Rings
3	NDP	B	702	-	-	4/34/77/77	0/5/5/5
5	GOL	A	704	-	-	1/4/4/4	-
5	GOL	B	704	-	-	0/4/4/4	-
2	UMP	A	701	-	-	1/10/22/22	0/2/2/2
4	DQF	B	703	-	-	6/18/18/18	0/3/3/3
2	UMP	B	701	-	-	6/10/22/22	0/2/2/2
3	NDP	A	702	-	-	3/34/77/77	0/5/5/5

All (43) bond length outliers are listed below:

Mol	Chain	Res	Type	Atoms	Z	Observed(Å)	Ideal(Å)
3	B	702	NDP	PA-O3	6.22	1.66	1.59
4	A	703	DQF	C5-CAI	-5.29	1.40	1.50
3	A	702	NDP	C2A-N1A	4.41	1.41	1.33
4	B	703	DQF	C5-CAI	-4.23	1.42	1.50
3	B	702	NDP	C2A-N1A	4.17	1.41	1.33
3	B	702	NDP	C4N-C3N	-4.03	1.42	1.50
3	A	702	NDP	C5A-N7A	-3.77	1.32	1.39
3	A	702	NDP	C4N-C3N	-3.17	1.44	1.50
3	B	702	NDP	C5A-N7A	-3.11	1.33	1.39
3	A	702	NDP	C2A-N3A	3.11	1.39	1.33
3	A	702	NDP	O4B-C1B	2.98	1.48	1.42
4	A	703	DQF	CAW-CAX	2.94	1.44	1.38
3	B	702	NDP	P2B-O2B	2.86	1.64	1.59
3	B	702	NDP	C4A-N9A	-2.82	1.31	1.37
3	A	702	NDP	C2N-C3N	2.82	1.42	1.35
3	A	702	NDP	C8A-N9A	-2.81	1.32	1.37
3	A	702	NDP	O3D-C3D	2.77	1.49	1.43
3	B	702	NDP	PN-O3	2.75	1.62	1.59
4	A	703	DQF	C6-N1	2.74	1.38	1.35
3	A	702	NDP	O4D-C1D	2.67	1.48	1.42
3	B	702	NDP	C5A-C4A	-2.63	1.34	1.39
3	B	702	NDP	C8A-N9A	-2.61	1.33	1.37
3	B	702	NDP	O4D-C1D	2.59	1.48	1.42
4	B	703	DQF	C4-N3	2.59	1.38	1.34
4	A	703	DQF	C4-N3	2.51	1.38	1.34
3	A	702	NDP	P2B-O3X	-2.44	1.45	1.54
3	A	702	NDP	PN-O3	2.43	1.62	1.59
3	B	702	NDP	C5A-C6A	-2.41	1.34	1.41
4	A	703	DQF	OAS-CAR	-2.40	1.35	1.43
3	A	702	NDP	PN-O2N	-2.37	1.44	1.55

Continued on next page...

Continued from previous page...

Mol	Chain	Res	Type	Atoms	Z	Observed(Å)	Ideal(Å)
3	B	702	NDP	C6N-C5N	2.35	1.40	1.33
4	B	703	DQF	CAJ-C4	-2.33	1.45	1.51
3	A	702	NDP	C6N-C5N	2.32	1.40	1.33
3	A	702	NDP	O3B-C3B	2.31	1.48	1.43
3	A	702	NDP	P2B-O2B	2.30	1.63	1.59
2	B	701	UMP	P-OP1	-2.26	1.43	1.50
3	B	702	NDP	C2N-C3N	2.23	1.41	1.35
3	B	702	NDP	C7N-C3N	-2.21	1.44	1.48
3	B	702	NDP	C2A-N3A	2.17	1.37	1.33
3	A	702	NDP	C2D-C1D	-2.16	1.46	1.53
3	B	702	NDP	P2B-O2X	-2.05	1.47	1.54
3	A	702	NDP	C5A-C4A	-2.02	1.35	1.39
3	B	702	NDP	P2B-O3X	-2.01	1.47	1.54

All (66) bond angle outliers are listed below:

Mol	Chain	Res	Type	Atoms	Z	Observed(°)	Ideal(°)
4	A	703	DQF	C2-N3-C4	12.48	125.36	116.26
4	B	703	DQF	C2-N3-C4	10.14	123.66	116.26
3	B	702	NDP	N3A-C2A-N1A	-6.44	118.83	128.58
3	A	702	NDP	N3A-C2A-N1A	-5.12	120.83	128.58
4	B	703	DQF	N3-C2-N1	-5.07	117.71	125.48
4	A	703	DQF	N3-C2-N1	-4.86	118.03	125.48
4	A	703	DQF	C5-C4-N3	-4.66	118.13	123.47
3	A	702	NDP	N9A-C8A-N7A	-4.48	107.58	113.94
3	A	702	NDP	C5A-N7A-C8A	4.44	110.44	103.45
3	A	702	NDP	C4A-C5A-N7A	-4.31	105.66	110.58
4	B	703	DQF	CBB-CBC-CBD	-4.28	103.35	114.51
3	A	702	NDP	C5A-C4A-N3A	-4.13	121.03	126.72
4	B	703	DQF	C5-C4-N3	-4.04	118.84	123.47
4	A	703	DQF	CAI-CAO-CAN	3.85	123.89	119.33
4	B	703	DQF	C2-N1-C6	3.83	121.88	117.28
3	B	702	NDP	N9A-C8A-N7A	-3.77	108.59	113.94
3	B	702	NDP	C4A-N9A-C1B	-3.43	118.61	126.63
4	A	703	DQF	CBA-OAZ-CAX	3.41	126.80	117.93
3	B	702	NDP	O4D-C1D-N1N	-3.21	101.96	108.08
3	B	702	NDP	O4B-C1B-N9A	3.20	114.23	108.09
3	B	702	NDP	C5A-C4A-N3A	-3.15	122.38	126.72
4	A	703	DQF	CAV-CAW-CAX	3.13	123.71	118.98
4	B	703	DQF	NAG-C6-N1	3.12	121.24	117.03
4	A	703	DQF	CAU-CAT-CAY	3.05	124.61	120.50
4	A	703	DQF	CAU-CAV-CAW	-3.05	116.33	120.24

Continued on next page...

Continued from previous page...

Mol	Chain	Res	Type	Atoms	Z	Observed(°)	Ideal(°)
4	A	703	DQF	OAS-CAR-CAQ	-3.01	97.22	108.30
3	B	702	NDP	C2B-C1B-N9A	-2.96	108.88	113.75
3	B	702	NDP	O2A-PA-O1A	2.93	126.08	112.44
3	B	702	NDP	C1B-N9A-C8A	2.91	133.55	127.09
2	A	701	UMP	O2-C2-N1	2.87	126.53	122.80
4	A	703	DQF	NAH-C2-N3	2.86	121.52	117.22
3	B	702	NDP	C2A-N3A-C4A	2.86	118.81	111.83
4	B	703	DQF	CBA-OAZ-CAX	-2.85	110.51	117.93
3	B	702	NDP	C4A-C5A-N7A	-2.81	107.37	110.58
3	A	702	NDP	C6A-C5A-C4A	2.81	121.02	117.18
4	B	703	DQF	NAH-C2-N1	2.79	121.40	117.22
3	A	702	NDP	O2B-P2B-O1X	-2.75	99.53	109.33
3	B	702	NDP	C5A-N7A-C8A	2.74	107.75	103.45
3	A	702	NDP	C2A-N3A-C4A	2.72	118.49	111.83
4	B	703	DQF	C5-C6-NAG	-2.72	117.38	120.82
4	A	703	DQF	CAJ-CAQ-CAR	-2.63	104.97	113.06
4	B	703	DQF	CAO-CAN-CL	-2.57	115.95	119.17
3	A	702	NDP	O2A-PA-O1A	2.55	124.32	112.44
3	A	702	NDP	C5A-C4A-N9A	2.54	108.58	105.81
3	B	702	NDP	C5A-C4A-N9A	2.45	108.48	105.81
4	B	703	DQF	NAH-C2-N3	2.44	120.89	117.22
4	A	703	DQF	C2-N1-C6	2.44	120.21	117.28
2	B	701	UMP	O2-C2-N1	2.43	125.95	122.80
4	B	703	DQF	CAI-CAO-CAN	2.42	122.20	119.33
3	B	702	NDP	C5A-C6A-N6A	-2.42	117.30	123.29
3	A	702	NDP	O2N-PN-O1N	2.41	123.65	112.44
4	A	703	DQF	CAK-CAI-CAO	-2.26	115.11	118.23
3	A	702	NDP	C2D-C1D-N1N	2.26	118.85	113.31
4	A	703	DQF	CBB-CBC-CBD	-2.25	108.64	114.51
3	A	702	NDP	C3B-C2B-C1B	-2.22	98.55	102.81
3	A	702	NDP	O4B-C1B-N9A	2.22	112.35	108.09
2	B	701	UMP	C1'-N1-C6	-2.18	117.24	121.53
4	A	703	DQF	NAH-C2-N1	2.16	120.46	117.22
4	B	703	DQF	CAM-CAN-CL	2.10	122.46	119.36
3	A	702	NDP	O4D-C1D-N1N	-2.09	104.10	108.08
3	A	702	NDP	C5A-C6A-N6A	-2.08	118.14	123.29
4	B	703	DQF	C5-C6-N1	-2.07	121.35	122.55
3	B	702	NDP	C6A-C5A-C4A	2.06	119.99	117.18
4	B	703	DQF	CAK-CAI-C5	2.05	124.31	120.80
4	A	703	DQF	OAS-CAT-CAY	-2.05	109.90	119.74
3	B	702	NDP	O5D-C5D-C4D	-2.04	102.06	108.99

There are no chirality outliers.

All (30) torsion outliers are listed below:

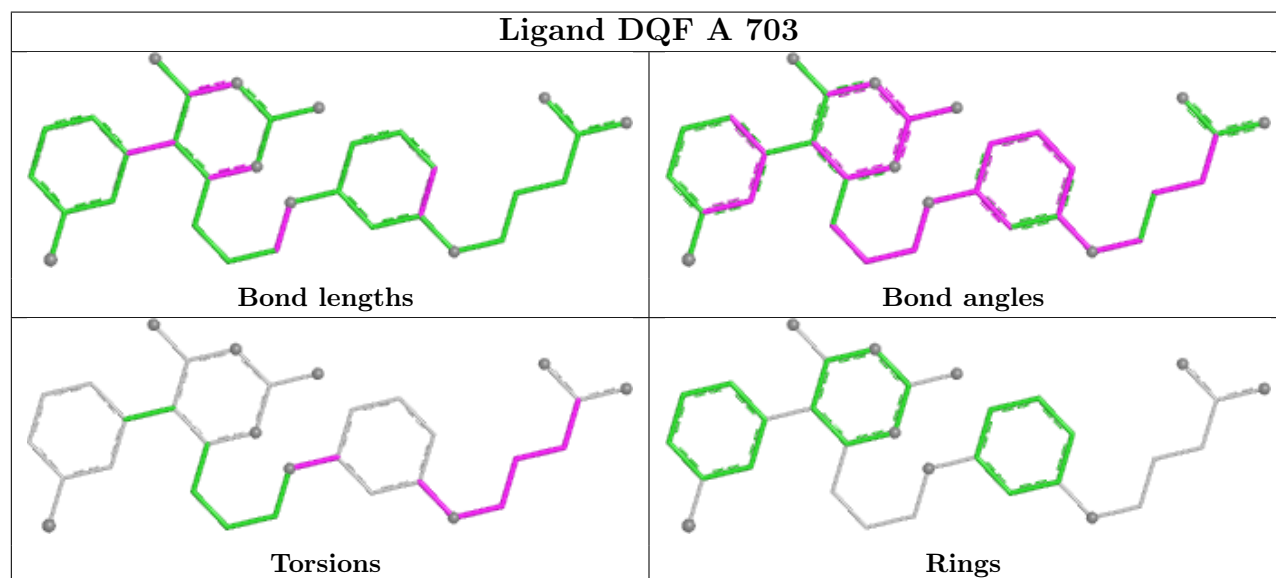
Mol	Chain	Res	Type	Atoms
2	B	701	UMP	C5'-O5'-P-OP3
4	B	703	DQF	CAW-CAX-OAZ-CBA
4	B	703	DQF	CAY-CAX-OAZ-CBA
2	B	701	UMP	C3'-C4'-C5'-O5'
2	B	701	UMP	O4'-C4'-C5'-O5'
4	A	703	DQF	OAZ-CBA-CBB-CBC
4	A	703	DQF	CBB-CBA-OAZ-CAX
2	B	701	UMP	C5'-O5'-P-OP1
4	A	703	DQF	CAY-CAX-OAZ-CBA
4	A	703	DQF	CBA-CBB-CBC-CBD
4	A	703	DQF	CAW-CAX-OAZ-CBA
4	B	703	DQF	OAZ-CBA-CBB-CBC
2	B	701	UMP	C5'-O5'-P-OP2
5	A	704	GOL	O2-C2-C3-O3
4	A	703	DQF	CAU-CAT-OAS-CAR
4	A	703	DQF	CAY-CAT-OAS-CAR
4	B	703	DQF	CBA-CBB-CBC-CBD
3	A	702	NDP	C2B-O2B-P2B-O2X
3	A	702	NDP	O4D-C1D-N1N-C2N
3	B	702	NDP	O4D-C1D-N1N-C2N
3	B	702	NDP	C2D-C1D-N1N-C2N
4	A	703	DQF	CBB-CBC-CBD-OBE
4	A	703	DQF	CBB-CBC-CBD-OBF
2	B	701	UMP	C4'-C5'-O5'-P
3	B	702	NDP	C2N-C3N-C7N-N7N
3	A	702	NDP	C2D-C1D-N1N-C2N
3	B	702	NDP	C3B-C4B-C5B-O5B
4	B	703	DQF	CBB-CBC-CBD-OBE
2	A	701	UMP	O4'-C4'-C5'-O5'
4	B	703	DQF	CBB-CBC-CBD-OBF

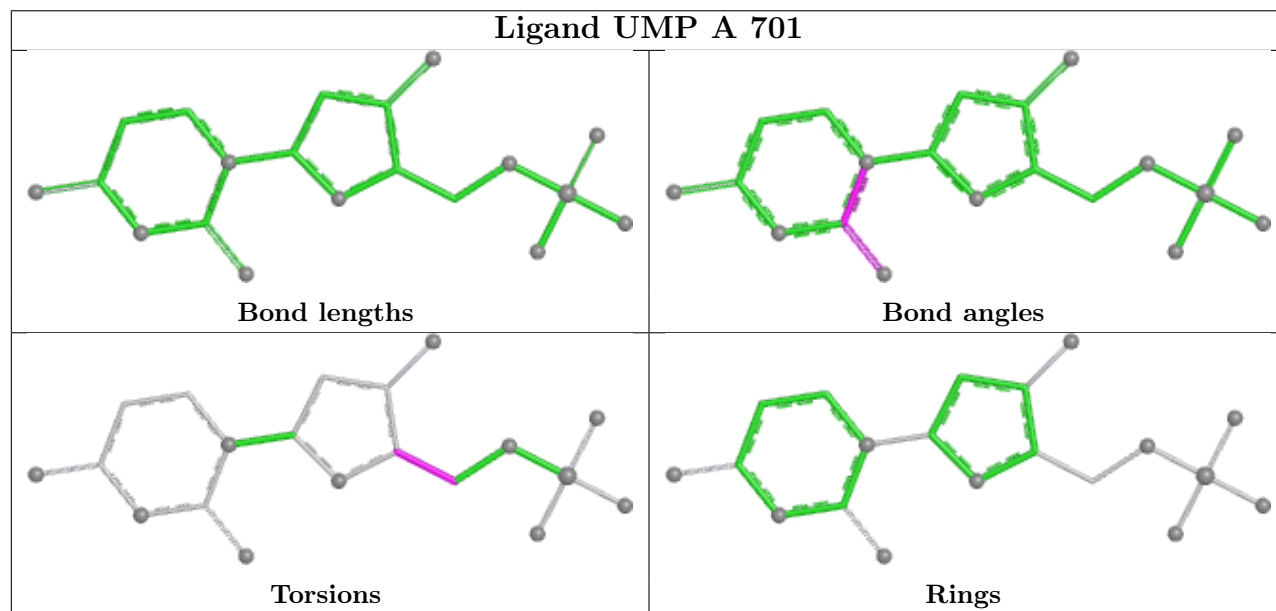
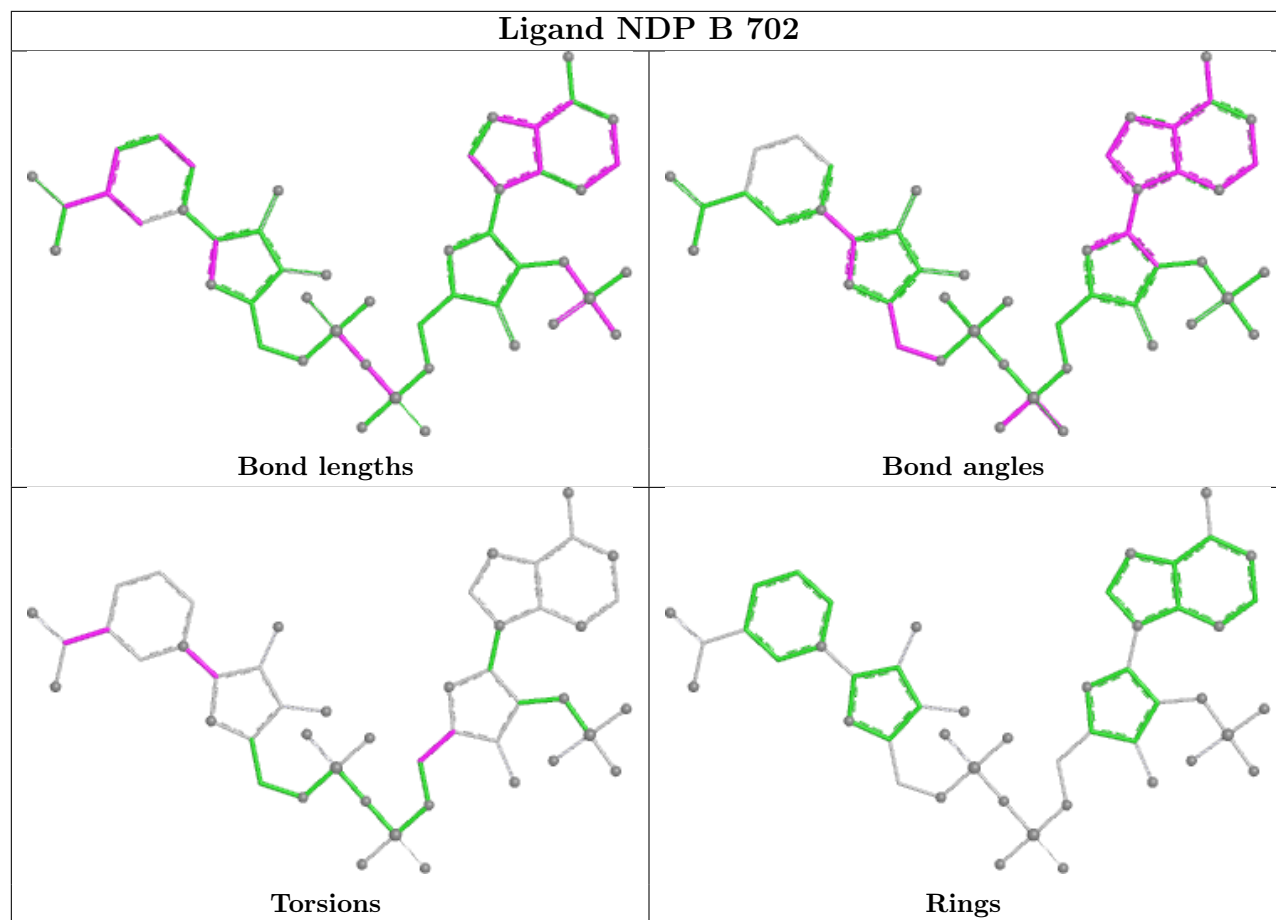
There are no ring outliers.

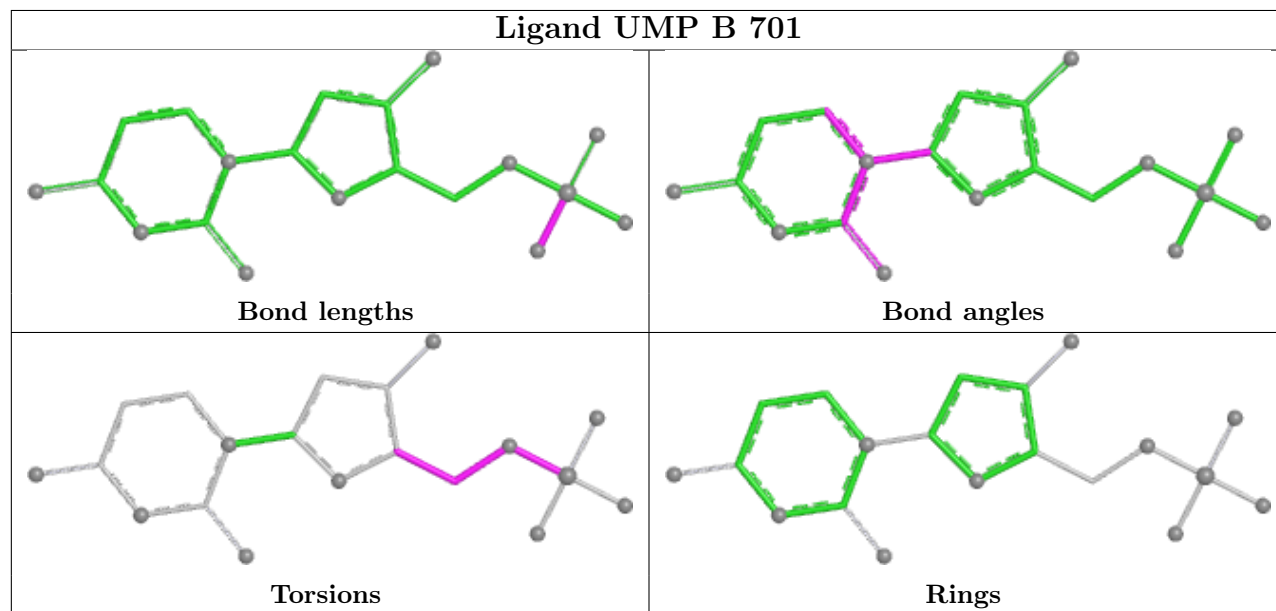
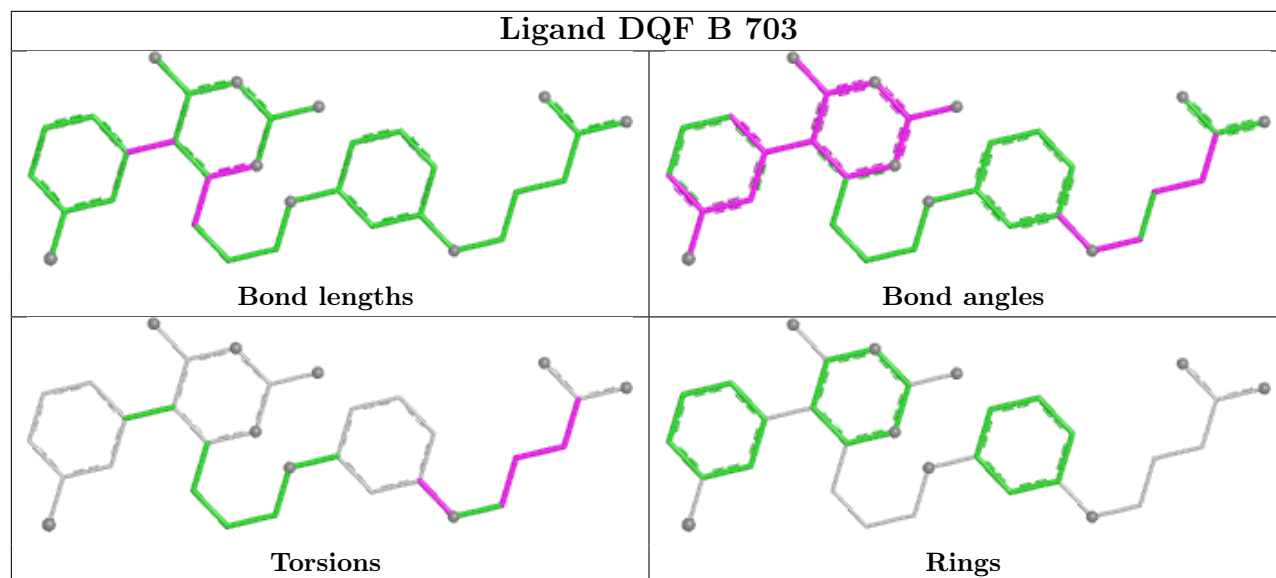
5 monomers are involved in 10 short contacts:

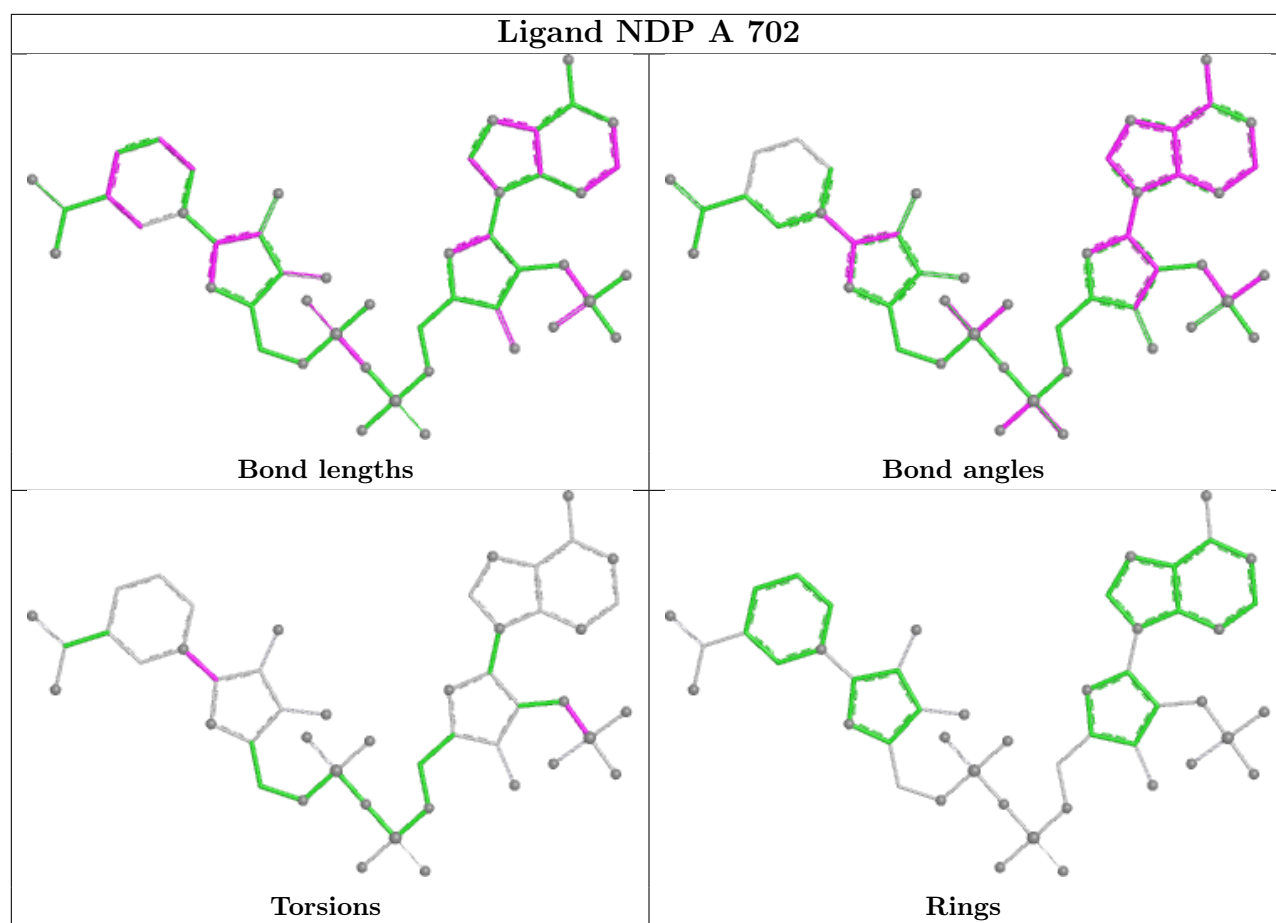
Mol	Chain	Res	Type	Clashes	Symm-Clashes
3	B	702	NDP	4	0
2	A	701	UMP	1	0
4	B	703	DQF	1	0
2	B	701	UMP	1	0
3	A	702	NDP	3	0

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

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	534/608 (87%)	0.17	31 (5%)	29 30	13, 26, 73, 116	0
1	B	534/608 (87%)	0.65	89 (16%)	4 4	13, 32, 87, 121	0
All	All	1068/1216 (87%)	0.41	120 (11%)	10 10	13, 28, 81, 121	0

All (120) RSRZ outliers are listed below:

Mol	Chain	Res	Type	RSRZ
1	B	136	PHE	5.5
1	A	307	ILE	5.3
1	B	131	LEU	5.2
1	B	309	PRO	4.9
1	B	116	PHE	4.8
1	B	307	ILE	4.7
1	B	346	THR	4.6
1	B	118	PRO	4.4
1	A	75	TYR	4.4
1	A	606	MET	4.2
1	B	142	ILE	4.0
1	A	348	VAL	3.9
1	A	309	PRO	3.9
1	A	346	THR	3.8
1	B	127	LEU	3.8
1	B	168	VAL	3.8
1	B	9	PHE	3.6
1	B	114	LYS	3.6
1	B	304	LYS	3.5
1	B	95	SER	3.5
1	B	87	ASP	3.5
1	A	285	GLU	3.5
1	B	285	GLU	3.5
1	A	303	ASN	3.5

Continued on next page...

Continued from previous page...

Mol	Chain	Res	Type	RSRZ
1	B	138	GLU	3.4
1	B	348	VAL	3.4
1	B	345	ARG	3.4
1	B	143	ILE	3.4
1	B	133	LYS	3.3
1	B	140	VAL	3.3
1	B	5	VAL	3.2
1	B	151	VAL	3.2
1	B	75	TYR	3.2
1	B	86	VAL	3.2
1	B	305	ASN	3.2
1	B	310	ASN	3.2
1	B	73	LEU	3.2
1	A	22	SER	3.2
1	A	306	SER	3.2
1	B	303	ASN	3.2
1	B	81	LEU	3.2
1	B	144	ASN	3.1
1	B	196	PHE	3.0
1	B	125	VAL	2.9
1	A	83	LYS	2.9
1	A	72	LYS	2.9
1	A	230	ASN	2.9
1	B	50	CYS	2.8
1	B	109	TRP	2.8
1	B	70	TYR	2.8
1	B	166	GLY	2.8
1	A	286	GLU	2.8
1	A	312	PHE	2.8
1	B	195	VAL	2.8
1	A	84	GLU	2.7
1	A	345	ARG	2.7
1	B	55	MET	2.7
1	B	126	ILE	2.7
1	A	27	LYS	2.7
1	B	312	PHE	2.7
1	B	85	THR	2.7
1	A	304	LYS	2.7
1	A	71	GLU	2.6
1	B	174	LEU	2.6
1	B	8	VAL	2.6
1	B	44	GLY	2.6

Continued on next page...

Continued from previous page...

Mol	Chain	Res	Type	RSRZ
1	B	119	LEU	2.6
1	B	35	TYR	2.6
1	B	141	TYR	2.6
1	B	169	VAL	2.6
1	B	157	ASN	2.6
1	A	114	LYS	2.6
1	B	74	LYS	2.6
1	B	80	TYR	2.5
1	B	145	LYS	2.5
1	B	605	ASP	2.5
1	B	123	ILE	2.5
1	B	130	THR	2.5
1	B	347	GLY	2.5
1	B	149	LEU	2.5
1	B	156	LEU	2.5
1	B	62	THR	2.4
1	A	375	PHE	2.4
1	B	173	PHE	2.4
1	B	97	LYS	2.4
1	B	129	ARG	2.4
1	B	11	ILE	2.3
1	B	146	VAL	2.3
1	B	47	PRO	2.3
1	B	110	GLU	2.3
1	B	82	ASN	2.3
1	B	117	LYS	2.3
1	A	283	ASP	2.3
1	A	605	ASP	2.3
1	B	230	ASN	2.3
1	B	45	VAL	2.2
1	A	96	LYS	2.2
1	B	308	HIS	2.2
1	A	343	SER	2.2
1	B	112	ILE	2.2
1	A	3	GLU	2.2
1	B	178	LEU	2.2
1	B	167	SER	2.2
1	B	43	LYS	2.2
1	B	107	THR	2.2
1	B	61	VAL	2.1
1	B	103	VAL	2.1
1	B	104	MET	2.1

Continued on next page...

Continued from previous page...

Mol	Chain	Res	Type	RSRZ
1	B	298	GLU	2.1
1	B	105	GLY	2.1
1	B	165	GLY	2.1
1	A	292	TYR	2.1
1	B	205	TYR	2.1
1	A	49	LYS	2.1
1	B	72	LYS	2.1
1	B	231	ASN	2.0
1	A	344	ASP	2.0
1	A	308	HIS	2.0
1	B	3	GLU	2.0
1	B	349	GLY	2.0

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

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

6.3 Carbohydrates [i](#)

There are no oligosaccharides in this entry.

6.4 Ligands [i](#)

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.

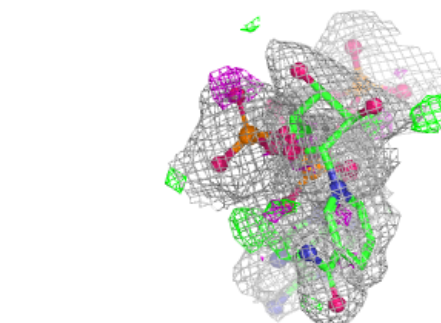
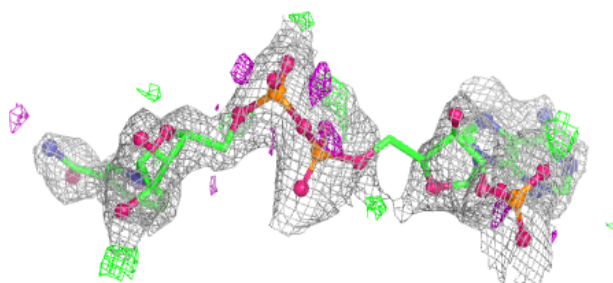
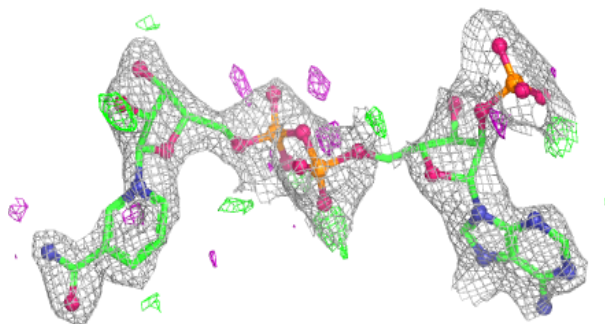
Mol	Type	Chain	Res	Atoms	RSCC	RSR	B-factors(Å ²)	Q<0.9
3	NDP	B	702	48/48	0.83	0.14	44,67,90,92	0
4	DQF	B	703	32/32	0.84	0.17	34,55,94,96	0
5	GOL	B	704	6/6	0.89	0.11	27,34,38,40	0
2	UMP	B	701	20/20	0.92	0.12	28,46,58,63	0
5	GOL	A	704	6/6	0.94	0.12	23,26,30,32	0
2	UMP	A	701	20/20	0.94	0.11	25,44,51,52	0
4	DQF	A	703	32/32	0.95	0.09	17,25,51,54	0
3	NDP	A	702	48/48	0.96	0.07	23,33,39,40	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.

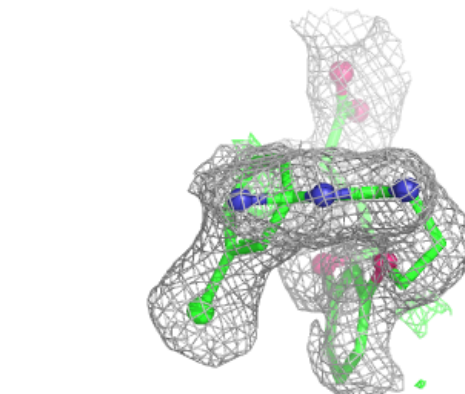
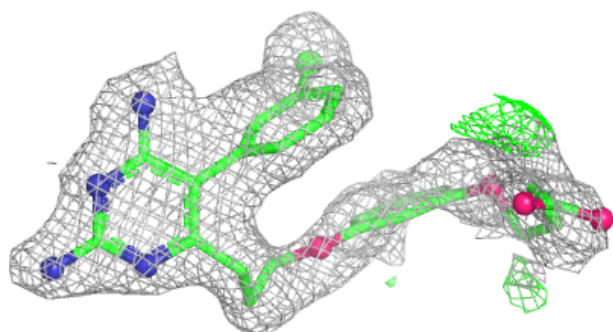
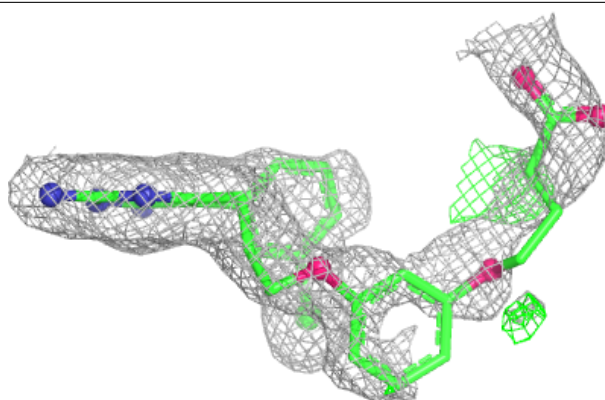
Electron density around NDP B 702:

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



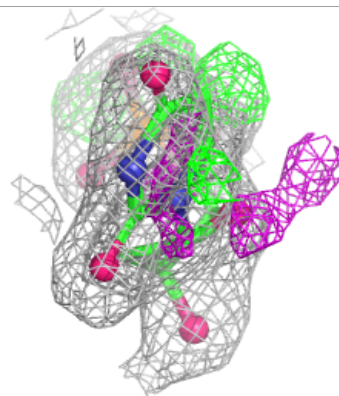
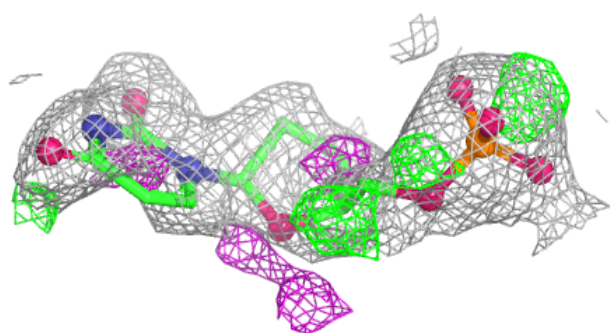
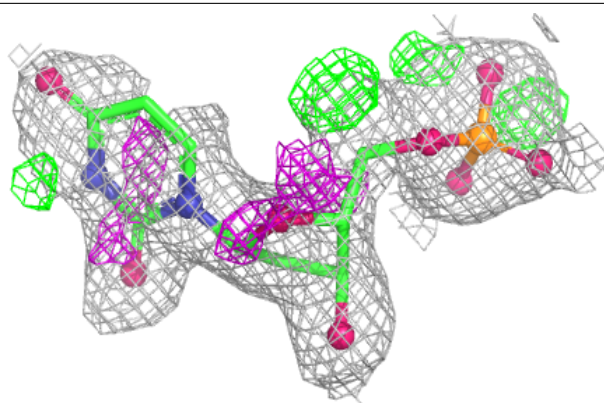
Electron density around DQF B 703:

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

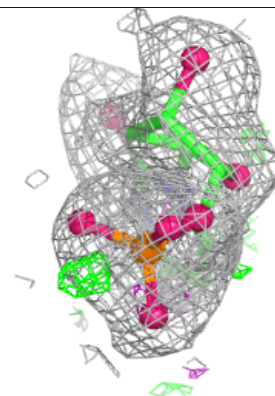
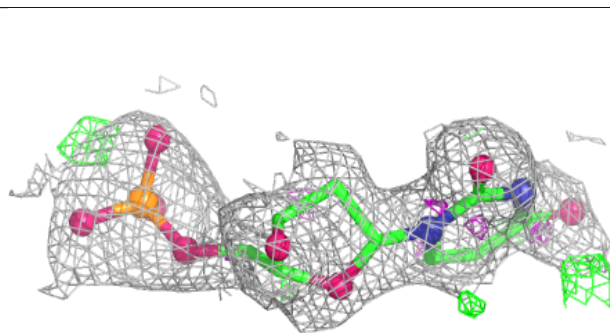
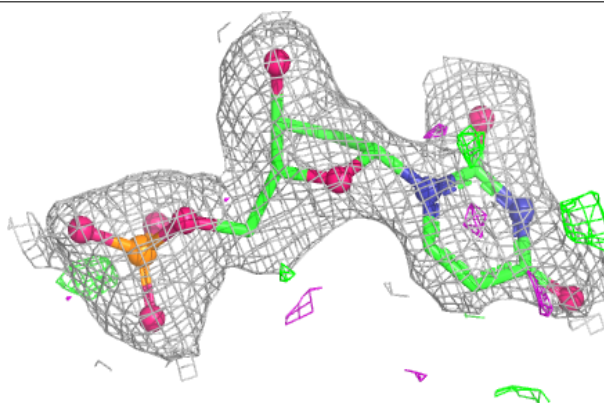


Electron density around UMP B 701:

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

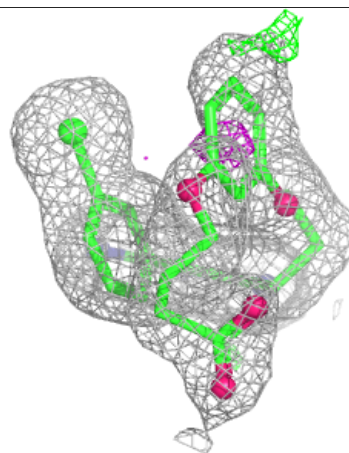
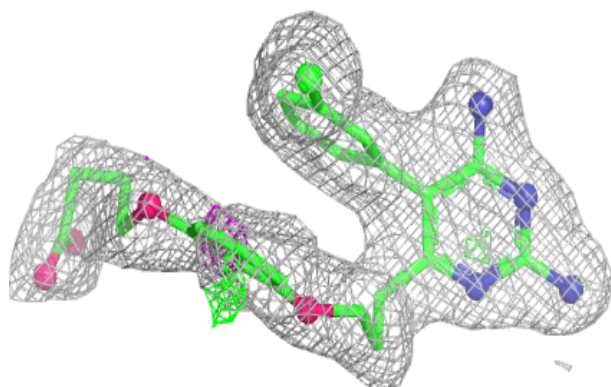
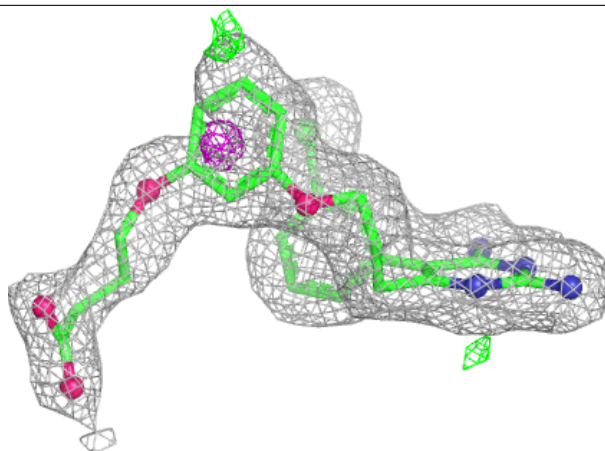
**Electron density around UMP A 701:**

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

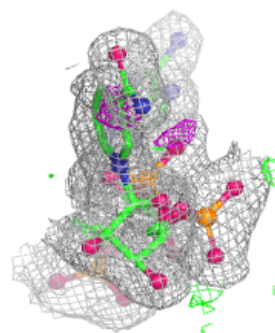
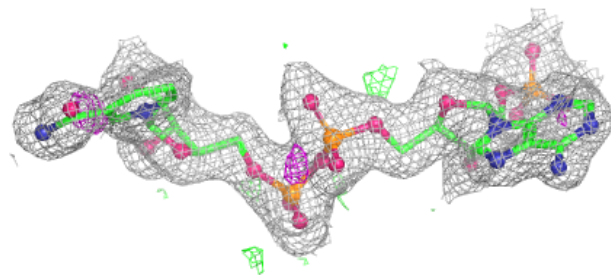
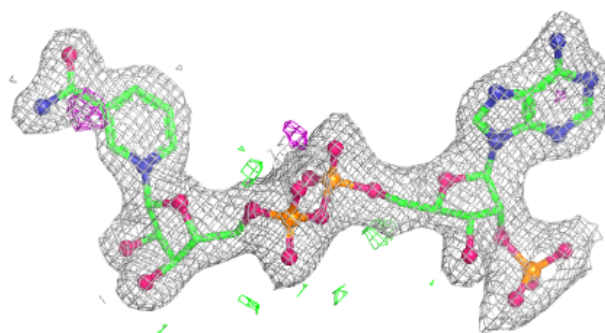


Electron density around DQF A 703:

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

**Electron density around NDP A 702:**

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



6.5 Other polymers [i](#)

There are no such residues in this entry.