



wwPDB X-ray Structure Validation Summary Report ⓘ

Apr 18, 2026 – 03:32 PM UTC

PDB ID : 3S29 / pdb_00003s29
Title : The crystal structure of sucrose synthase-1 from Arabidopsis thaliana and its functional implications.
Authors : Zheng, Y.I.; Garavito, R.M.
Deposited on : 2011-05-16
Resolution : 2.85 Å(reported)

This is a wwPDB X-ray Structure Validation Summary Report for a publicly released PDB entry.

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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

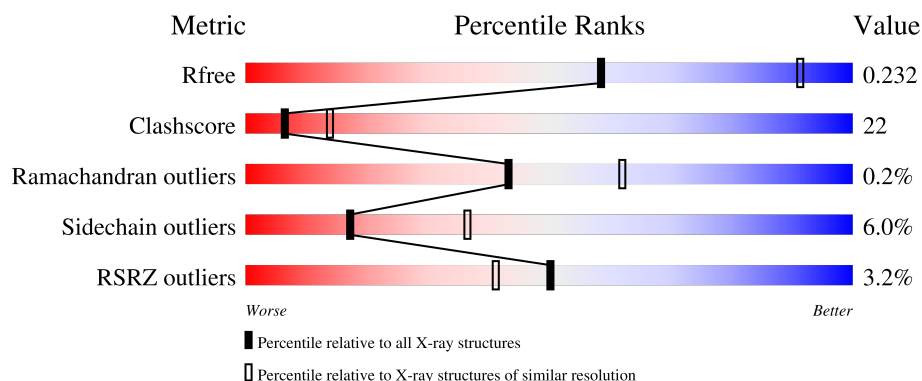
1 Overall quality at a glance

The following experimental techniques were used to determine the structure:

X-RAY DIFFRACTION

The reported resolution of this entry is 2.85 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	1407 (2.88-2.84)
Clashscore	190562	1446 (2.88-2.84)
Ramachandran outliers	187476	1406 (2.88-2.84)
Sidechain outliers	187428	1407 (2.88-2.84)
RSRZ outliers	180081	1408 (2.88-2.84)

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	816	3% 63% 29% • •
1	B	816	6% 61% 33% • •
1	C	816	2% 63% 30% • •
1	D	816	3% 65% 28% • •
1	E	816	3% 63% 30% • •

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Mol	Chain	Length	Quality of chain
1	F	816	
1	G	816	
1	H	816	

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	FRU	A	902	-	-	X	-
3	FRU	B	902	-	-	X	-
3	FRU	E	902	-	-	X	-
4	SO4	B	913	-	-	X	-
4	SO4	E	913	-	-	X	-

2 Entry composition

There are 7 unique types of molecules in this entry. The entry contains 51504 atoms, of which 24 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 Sucrose synthase 1.

Mol	Chain	Residues	Atoms					ZeroOcc	AltConf	Trace
1	A	781	Total	C	N	O	S	0	0	0
			6280	4033	1066	1159	22			
1	B	791	Total	C	N	O	S	0	0	0
			6321	4056	1073	1170	22			
1	C	781	Total	C	N	O	S	0	0	0
			6294	4047	1065	1160	22			
1	D	781	Total	C	N	O	S	0	0	0
			6275	4032	1062	1159	22			
1	E	781	Total	C	N	O	S	0	0	0
			6275	4031	1063	1159	22			
1	F	781	Total	C	N	O	S	0	0	0
			6299	4047	1070	1160	22			
1	G	781	Total	C	N	O	S	0	0	0
			6301	4047	1070	1162	22			
1	H	797	Total	C	N	O	S	0	0	0
			6398	4101	1091	1184	22			

There are 64 discrepancies between the modelled and reference sequences:

Chain	Residue	Modelled	Actual	Comment	Reference
A	809	VAL	-	expression tag	UNP P49040
A	810	GLU	-	expression tag	UNP P49040
A	811	HIS	-	expression tag	UNP P49040
A	812	HIS	-	expression tag	UNP P49040
A	813	HIS	-	expression tag	UNP P49040
A	814	HIS	-	expression tag	UNP P49040
A	815	HIS	-	expression tag	UNP P49040
A	816	HIS	-	expression tag	UNP P49040
B	809	VAL	-	expression tag	UNP P49040
B	810	GLU	-	expression tag	UNP P49040
B	811	HIS	-	expression tag	UNP P49040
B	812	HIS	-	expression tag	UNP P49040
B	813	HIS	-	expression tag	UNP P49040

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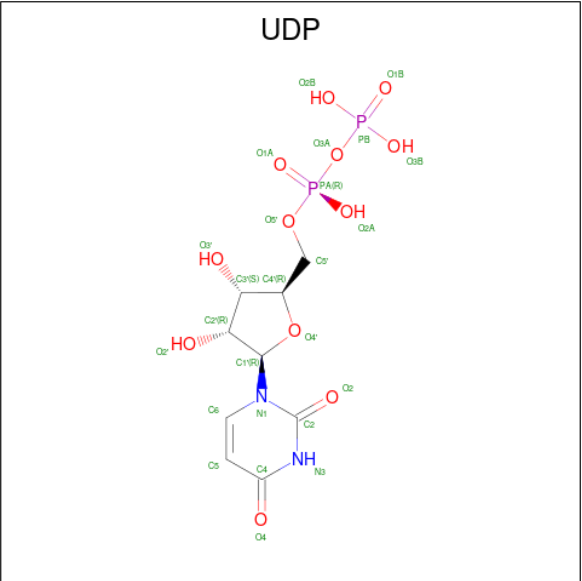
Chain	Residue	Modelled	Actual	Comment	Reference
B	814	HIS	-	expression tag	UNP P49040
B	815	HIS	-	expression tag	UNP P49040
B	816	HIS	-	expression tag	UNP P49040
C	809	VAL	-	expression tag	UNP P49040
C	810	GLU	-	expression tag	UNP P49040
C	811	HIS	-	expression tag	UNP P49040
C	812	HIS	-	expression tag	UNP P49040
C	813	HIS	-	expression tag	UNP P49040
C	814	HIS	-	expression tag	UNP P49040
C	815	HIS	-	expression tag	UNP P49040
C	816	HIS	-	expression tag	UNP P49040
D	809	VAL	-	expression tag	UNP P49040
D	810	GLU	-	expression tag	UNP P49040
D	811	HIS	-	expression tag	UNP P49040
D	812	HIS	-	expression tag	UNP P49040
D	813	HIS	-	expression tag	UNP P49040
D	814	HIS	-	expression tag	UNP P49040
D	815	HIS	-	expression tag	UNP P49040
D	816	HIS	-	expression tag	UNP P49040
E	809	VAL	-	expression tag	UNP P49040
E	810	GLU	-	expression tag	UNP P49040
E	811	HIS	-	expression tag	UNP P49040
E	812	HIS	-	expression tag	UNP P49040
E	813	HIS	-	expression tag	UNP P49040
E	814	HIS	-	expression tag	UNP P49040
E	815	HIS	-	expression tag	UNP P49040
E	816	HIS	-	expression tag	UNP P49040
F	809	VAL	-	expression tag	UNP P49040
F	810	GLU	-	expression tag	UNP P49040
F	811	HIS	-	expression tag	UNP P49040
F	812	HIS	-	expression tag	UNP P49040
F	813	HIS	-	expression tag	UNP P49040
F	814	HIS	-	expression tag	UNP P49040
F	815	HIS	-	expression tag	UNP P49040
F	816	HIS	-	expression tag	UNP P49040
G	809	VAL	-	expression tag	UNP P49040
G	810	GLU	-	expression tag	UNP P49040
G	811	HIS	-	expression tag	UNP P49040
G	812	HIS	-	expression tag	UNP P49040
G	813	HIS	-	expression tag	UNP P49040
G	814	HIS	-	expression tag	UNP P49040
G	815	HIS	-	expression tag	UNP P49040

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Chain	Residue	Modelled	Actual	Comment	Reference
G	816	HIS	-	expression tag	UNP P49040
H	809	VAL	-	expression tag	UNP P49040
H	810	GLU	-	expression tag	UNP P49040
H	811	HIS	-	expression tag	UNP P49040
H	812	HIS	-	expression tag	UNP P49040
H	813	HIS	-	expression tag	UNP P49040
H	814	HIS	-	expression tag	UNP P49040
H	815	HIS	-	expression tag	UNP P49040
H	816	HIS	-	expression tag	UNP P49040

- Molecule 2 is URIDINE-5'-DIPHOSPHATE (CCD ID: UDP) (formula: $C_9H_{14}N_2O_{12}P_2$).



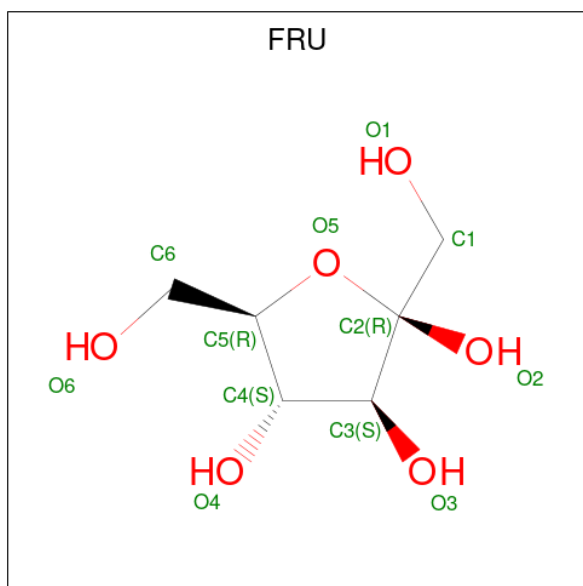
Mol	Chain	Residues	Atoms					ZeroOcc	AltConf
2	A	1	Total	C	N	O	P	0	0
			25	9	2	12	2		
2	B	1	Total	C	N	O	P	0	0
			25	9	2	12	2		
2	C	1	Total	C	N	O	P	0	0
			25	9	2	12	2		
2	D	1	Total	C	N	O	P	0	0
			25	9	2	12	2		
2	E	1	Total	C	N	O	P	0	0
			25	9	2	12	2		
2	F	1	Total	C	N	O	P	0	0
			25	9	2	12	2		
2	G	1	Total	C	N	O	P	0	0
			25	9	2	12	2		

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

- Molecule 3 is beta-D-fructofuranose (CCD ID: FRU) (formula: $C_6H_{12}O_6$).



Mol	Chain	Residues	Atoms			ZeroOcc	AltConf
3	A	1	Total	C	O	0	0
			12	6	6		
3	B	1	Total	C	O	0	0
			12	6	6		
3	C	1	Total	C	O	0	0
			12	6	6		
3	D	1	Total	C	O	0	0
			12	6	6		
3	E	1	Total	C	O	0	0
			12	6	6		
3	F	1	Total	C	O	0	0
			12	6	6		
3	G	1	Total	C	O	0	0
			12	6	6		
3	H	1	Total	C	O	0	0
			12	6	6		

- Molecule 4 is SULFATE ION (CCD ID: SO4) (formula: O_4S).



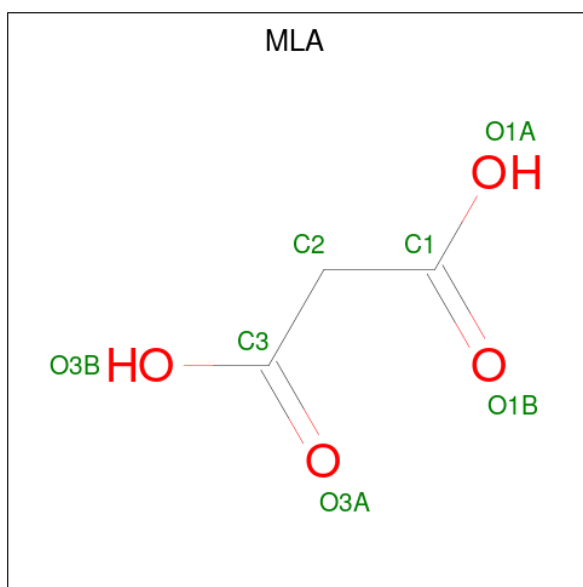
Mol	Chain	Residues	Atoms			ZeroOcc	AltConf
4	A	1	Total	O	S	0	0
			5	4	1		
4	A	1	Total	O	S	0	0
			5	4	1		
4	A	1	Total	O	S	0	0
			5	4	1		
4	A	1	Total	O	S	0	0
			5	4	1		
4	B	1	Total	O	S	0	0
			5	4	1		
4	B	1	Total	O	S	0	0
			5	4	1		
4	B	1	Total	O	S	0	0
			5	4	1		
4	C	1	Total	O	S	0	0
			5	4	1		
4	C	1	Total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

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Mol	Chain	Residues	Atoms			ZeroOcc	AltConf
4	D	1	Total	O	S	0	0
			5	4	1		
4	E	1	Total	O	S	0	0
			5	4	1		
4	E	1	Total	O	S	0	0
			5	4	1		
4	E	1	Total	O	S	0	0
			5	4	1		
4	E	1	Total	O	S	0	0
			5	4	1		
4	F	1	Total	O	S	0	0
			5	4	1		
4	F	1	Total	O	S	0	0
			5	4	1		
4	F	1	Total	O	S	0	0
			5	4	1		
4	F	1	Total	O	S	0	0
			5	4	1		
4	G	1	Total	O	S	0	0
			5	4	1		
4	G	1	Total	O	S	0	0
			5	4	1		
4	G	1	Total	O	S	0	0
			5	4	1		
4	G	1	Total	O	S	0	0
			5	4	1		
4	H	1	Total	O	S	0	0
			5	4	1		
4	H	1	Total	O	S	0	0
			5	4	1		
4	H	1	Total	O	S	0	0
			5	4	1		

- Molecule 5 is MALONIC ACID (CCD ID: MLA) (formula: C₃H₄O₄).



Mol	Chain	Residues	Atoms				ZeroOcc	AltConf
5	A	1	Total	C	H	O	0	0
			9	3	2	4		
5	B	1	Total	C	H	O	0	0
			9	3	2	4		
5	C	1	Total	C	H	O	0	0
			9	3	2	4		
5	D	1	Total	C	H	O	0	0
			9	3	2	4		
5	D	1	Total	C	H	O	0	0
			9	3	2	4		
5	E	1	Total	C	H	O	0	0
			9	3	2	4		
5	F	1	Total	C	H	O	0	0
			9	3	2	4		
5	F	1	Total	C	H	O	0	0
			9	3	2	4		
5	G	1	Total	C	H	O	0	0
			9	3	2	4		
5	G	1	Total	C	H	O	0	0
			9	3	2	4		
5	H	1	Total	C	H	O	0	0
			9	3	2	4		
5	H	1	Total	C	H	O	0	0
			9	3	2	4		

- Molecule 6 is POTASSIUM ION (CCD ID: K) (formula: K).

Mol	Chain	Residues	Atoms	ZeroOcc	AltConf
6	A	1	Total K 1 1	0	0
6	B	1	Total K 1 1	0	0
6	C	1	Total K 1 1	0	0
6	D	1	Total K 1 1	0	0
6	E	1	Total K 1 1	0	0
6	F	1	Total K 1 1	0	0
6	G	1	Total K 1 1	0	0
6	H	1	Total K 1 1	0	0

- Molecule 7 is water.

Mol	Chain	Residues	Atoms	ZeroOcc	AltConf
7	A	76	Total O 76 76	0	0
7	B	62	Total O 62 62	0	0
7	C	38	Total O 38 38	0	0
7	D	64	Total O 64 64	0	0
7	E	58	Total O 58 58	0	0
7	F	80	Total O 80 80	0	0
7	G	71	Total O 71 71	0	0
7	H	50	Total O 50 50	0	0

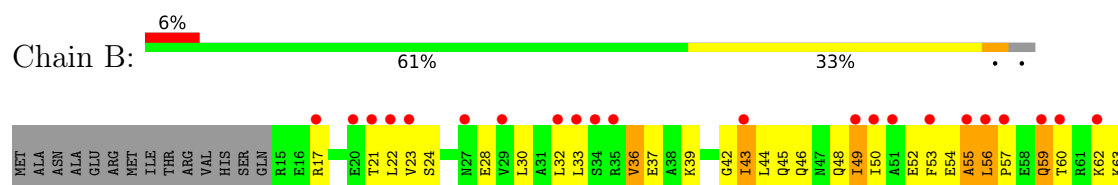
3 Residue-property plots

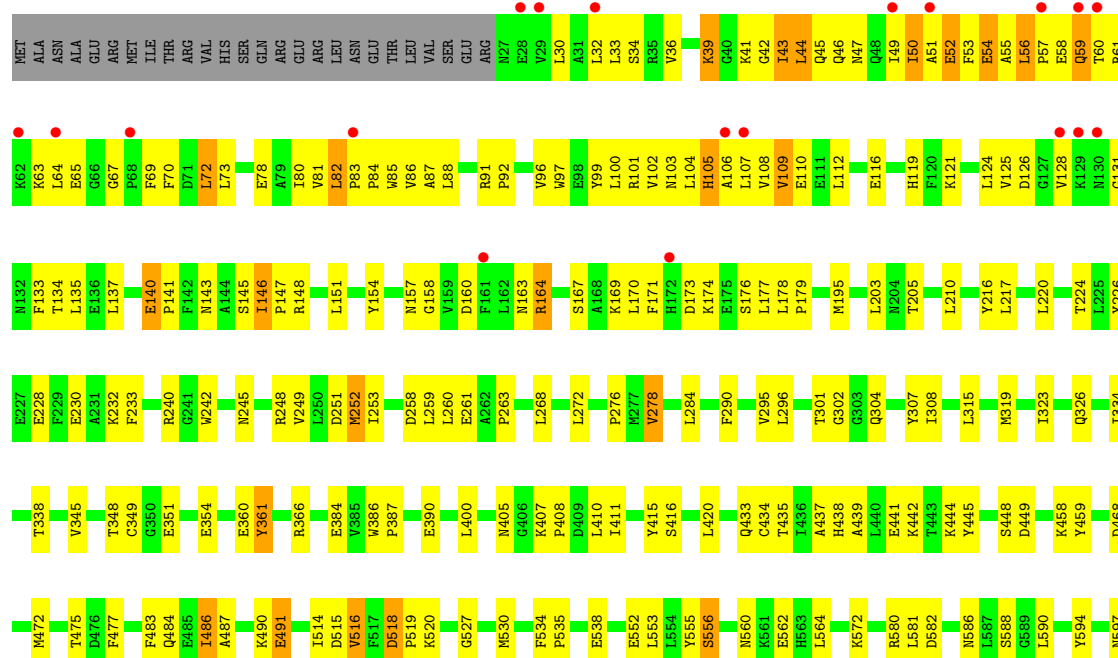
These plots are drawn for all protein, RNA, DNA and oligosaccharide chains in the entry. The first graphic for a chain summarises the proportions of the various outlier classes displayed in the second graphic. The second graphic shows the sequence view annotated by issues in geometry and electron density. 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.

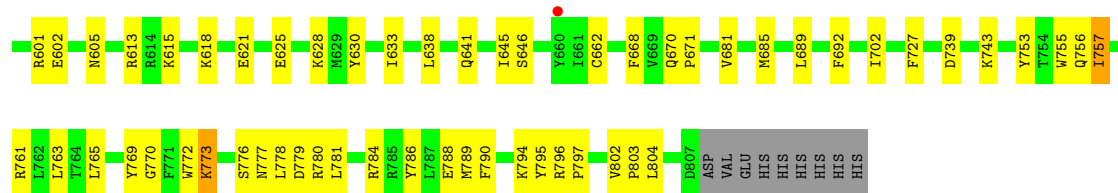
• Molecule 1: Sucrose synthase 1



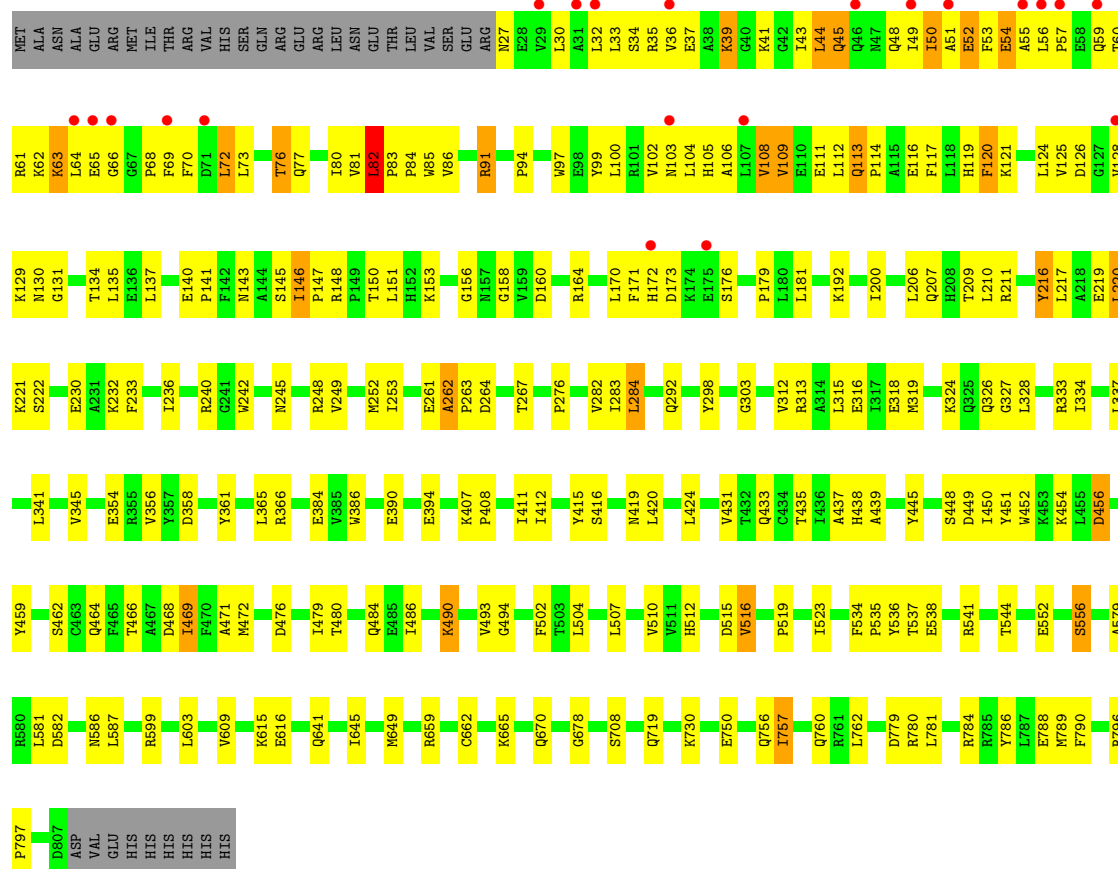
• Molecule 1: Sucrose synthase 1



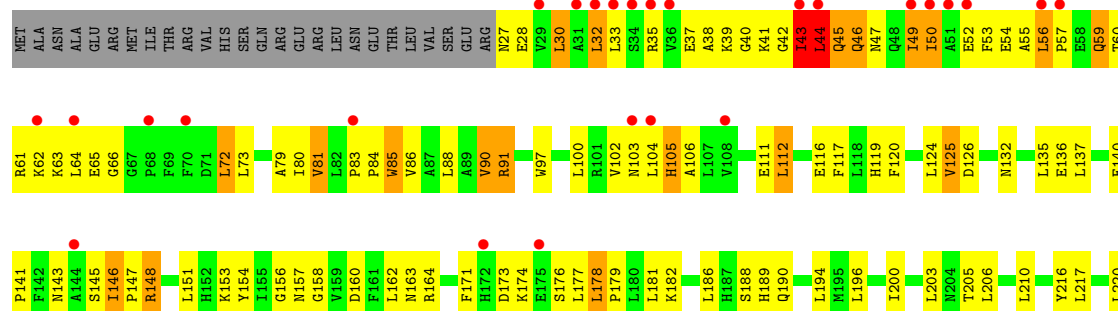




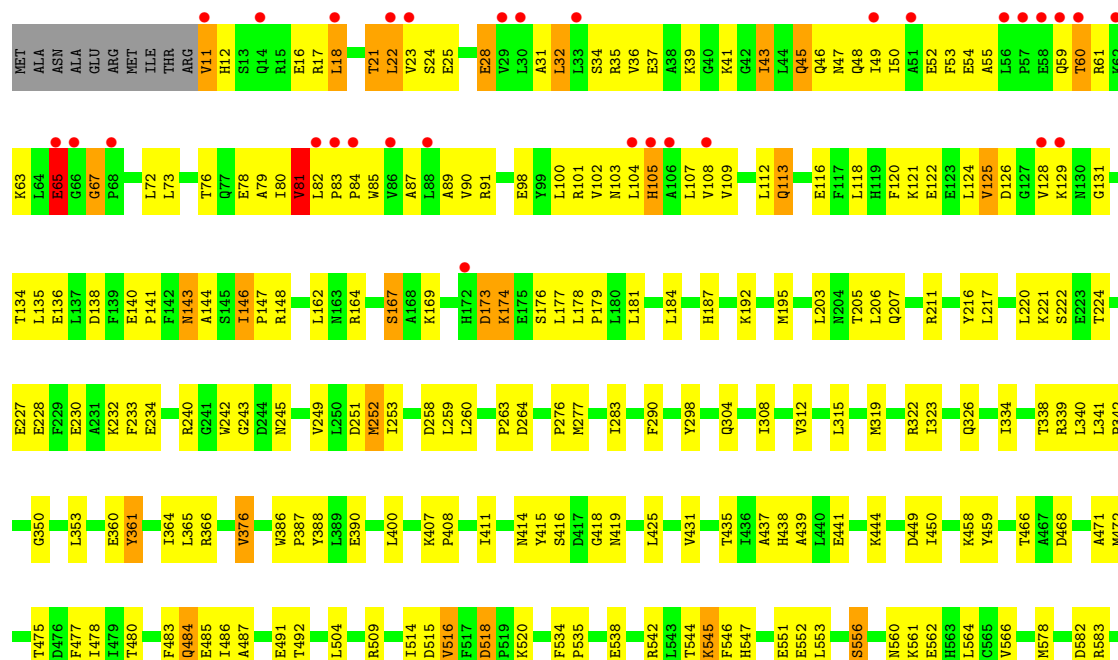
• Molecule 1: Sucrose synthase 1

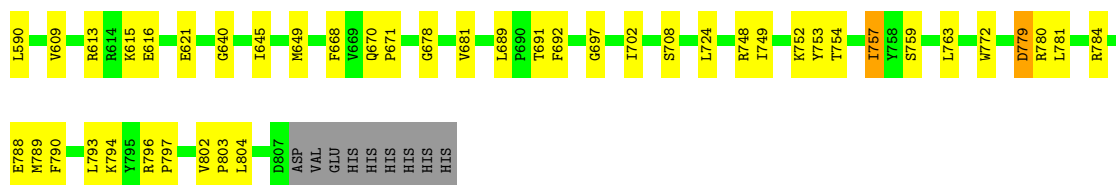


• Molecule 1: Sucrose synthase 1









4 Data and refinement statistics

Property	Value	Source
Space group	C 1 2 1	Depositor
Cell constants a, b, c, α , β , γ	277.16Å 261.50Å 161.10Å 90.00° 109.27° 90.00°	Depositor
Resolution (Å)	24.96 – 2.85 24.96 – 2.85	Depositor EDS
% Data completeness (in resolution range)	99.3 (24.96-2.85) 99.2 (24.96-2.85)	Depositor EDS
R_{merge}	(Not available)	Depositor
R_{sym}	0.14	Depositor
$\langle I/\sigma(I) \rangle$ ¹	1.89 (at 2.86Å)	Xtriage
Refinement program	PHENIX 1.7_650	Depositor
R, R_{free}	0.185 , 0.234 0.184 , 0.232	Depositor DCC
R_{free} test set	11907 reflections (4.77%)	wwPDB-VP
Wilson B-factor (Å ²)	44.6	Xtriage
Anisotropy	0.179	Xtriage
Bulk solvent k_{sol} (e/Å ³), B_{sol} (Å ²)	0.33 , 42.6	EDS
L-test for twinning ²	$\langle L \rangle = 0.47$, $\langle L^2 \rangle = 0.30$	Xtriage
Estimated twinning fraction	No twinning to report.	Xtriage
F_o, F_c correlation	0.94	EDS
Total number of atoms	51504	wwPDB-VP
Average B, all atoms (Å ²)	46.0	wwPDB-VP

Xtriage's analysis on translational NCS is as follows: *The analyses of the Patterson function reveals a significant off-origin peak that is 24.47 % of the origin peak, indicating pseudo-translational symmetry. The chance of finding a peak of this or larger height randomly in a structure without pseudo-translational symmetry is equal to 3.8124e-03. The detected translational NCS is most likely also responsible for the elevated intensity ratio.*

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: UDP, FRU, SO4, MLA, K

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	0.45	0/6427	0.85	8/8703 (0.1%)
1	B	0.43	0/6467	0.85	5/8761 (0.1%)
1	C	0.41	0/6441	0.82	7/8723 (0.1%)
1	D	0.44	0/6422	0.87	15/8700 (0.2%)
1	E	0.42	0/6421	0.88	15/8697 (0.2%)
1	F	0.44	0/6446	0.88	17/8728 (0.2%)
1	G	0.44	0/6448	0.85	7/8731 (0.1%)
1	H	0.43	0/6546	0.87	14/8867 (0.2%)
All	All	0.44	0/51618	0.86	88/69910 (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	B	0	1
1	F	0	1
All	All	0	2

There are no bond length outliers.

The worst 5 of 88 bond angle outliers are listed below:

Mol	Chain	Res	Type	Atoms	Z	Observed(°)	Ideal(°)
1	G	82	LEU	CA-C-N	12.19	132.94	120.38
1	G	82	LEU	C-N-CA	12.19	132.94	120.38
1	F	82	LEU	CA-C-N	11.22	131.93	120.38
1	F	82	LEU	C-N-CA	11.22	131.93	120.38
1	A	47	ASN	N-CA-C	9.21	124.24	112.92

There are no chirality outliers.

All (2) planarity outliers are listed below:

Mol	Chain	Res	Type	Group
1	B	143	ASN	Peptide
1	F	83	PRO	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	6280	0	6200	290	0
1	B	6321	0	6203	316	0
1	C	6294	0	6244	281	0
1	D	6275	0	6197	268	0
1	E	6275	0	6205	284	0
1	F	6299	0	6247	291	0
1	G	6301	0	6247	292	0
1	H	6398	0	6301	295	0
2	A	25	0	11	1	0
2	B	25	0	11	2	0
2	C	25	0	11	0	0
2	D	25	0	11	0	0
2	E	25	0	11	1	0
2	F	25	0	11	1	0
2	G	25	0	11	1	0
2	H	25	0	11	0	0
3	A	12	0	12	8	0
3	B	12	0	12	6	0
3	C	12	0	12	4	0
3	D	12	0	12	0	0
3	E	12	0	12	12	0
3	F	12	0	12	0	0
3	G	12	0	12	0	0
3	H	12	0	12	1	0
4	A	25	0	0	2	0
4	B	15	0	0	3	0
4	C	15	0	0	0	0
4	D	20	0	0	1	0

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Mol	Chain	Non-H	H(model)	H(added)	Clashes	Symm-Clashes
4	E	20	0	0	4	0
4	F	20	0	0	0	0
4	G	20	0	0	1	0
4	H	15	0	0	0	0
5	A	7	2	2	0	0
5	B	7	2	2	0	0
5	C	7	2	2	0	0
5	D	14	4	4	2	0
5	E	7	2	2	0	0
5	F	14	4	4	2	0
5	G	14	4	4	0	0
5	H	14	4	4	1	0
6	A	1	0	0	0	0
6	B	1	0	0	1	0
6	C	1	0	0	0	0
6	D	1	0	0	0	0
6	E	1	0	0	0	0
6	F	1	0	0	0	0
6	G	1	0	0	0	0
6	H	1	0	0	0	0
7	A	76	0	0	3	0
7	B	62	0	0	4	0
7	C	38	0	0	1	0
7	D	64	0	0	3	0
7	E	58	0	0	4	0
7	F	80	0	0	0	0
7	G	71	0	0	3	0
7	H	50	0	0	2	0
All	All	51480	24	50052	2215	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 22.

The worst 5 of 2215 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:D:145:SER:HB3	1:D:779:ASP:OD2	1.16	1.31
1:G:66:GLY:C	1:G:68:PRO:HD3	1.57	1.28
1:G:119:HIS:CE1	1:G:129:LYS:HD2	1.73	1.21
1:B:315:LEU:HG	1:B:319:MET:HE2	1.24	1.20
1:H:46:GLN:HB2	1:H:79:ALA:HB3	1.20	1.18

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	779/816 (96%)	737 (95%)	38 (5%)	4 (0%)	24	42
1	B	787/816 (96%)	732 (93%)	51 (6%)	4 (0%)	24	42
1	C	779/816 (96%)	741 (95%)	38 (5%)	0	100	100
1	D	779/816 (96%)	739 (95%)	39 (5%)	1 (0%)	48	68
1	E	779/816 (96%)	740 (95%)	38 (5%)	1 (0%)	48	68
1	F	779/816 (96%)	736 (94%)	41 (5%)	2 (0%)	36	54
1	G	779/816 (96%)	741 (95%)	36 (5%)	2 (0%)	36	54
1	H	795/816 (97%)	751 (94%)	43 (5%)	1 (0%)	48	68
All	All	6256/6528 (96%)	5917 (95%)	324 (5%)	15 (0%)	43	62

5 of 15 Ramachandran outliers are listed below:

Mol	Chain	Res	Type
1	B	55	ALA
1	B	83	PRO
1	A	63	LYS
1	D	63	LYS
1	A	55	ALA

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	668/718 (93%)	622 (93%)	46 (7%)	14	30
1	B	668/718 (93%)	627 (94%)	41 (6%)	17	35
1	C	674/718 (94%)	636 (94%)	38 (6%)	19	40
1	D	669/718 (93%)	636 (95%)	33 (5%)	22	45
1	E	669/718 (93%)	629 (94%)	40 (6%)	17	36
1	F	674/718 (94%)	631 (94%)	43 (6%)	16	33
1	G	675/718 (94%)	628 (93%)	47 (7%)	14	29
1	H	681/718 (95%)	645 (95%)	36 (5%)	20	42
All	All	5378/5744 (94%)	5054 (94%)	324 (6%)	17	36

5 of 324 residues with a non-rotameric sidechain are listed below:

Mol	Chain	Res	Type
1	F	623	LYS
1	G	781	LEU
1	F	773	LYS
1	G	205	THR
1	H	112	LEU

Sometimes sidechains can be flipped to improve hydrogen bonding and reduce clashes. 5 of 108 such sidechains are listed below:

Mol	Chain	Res	Type
1	E	189	HIS
1	F	287	HIS
1	H	105	HIS
1	E	294	ASN
1	E	639	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 [i](#)

There are no oligosaccharides in this entry.

5.6 Ligand geometry [i](#)

Of 66 ligands modelled in this entry, 8 are monoatomic - leaving 58 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	MLA	G	921	-	6,6,6	1.11	0	7,7,7	1.63	1 (14%)
2	UDP	D	901	-	25,26,26	1.09	1 (4%)	38,40,40	1.60	4 (10%)
4	SO4	A	913	-	4,4,4	0.34	0	6,6,6	0.16	0
2	UDP	A	901	-	25,26,26	0.99	0	38,40,40	1.60	5 (13%)
4	SO4	H	911	-	4,4,4	0.36	0	6,6,6	0.21	0
3	FRU	B	902	-	11,12,12	0.67	0	10,18,18	1.22	1 (10%)
3	FRU	H	902	-	11,12,12	1.13	1 (9%)	10,18,18	1.24	0
4	SO4	G	911	-	4,4,4	0.31	0	6,6,6	0.21	0
4	SO4	D	913	-	4,4,4	0.34	0	6,6,6	0.09	0
4	SO4	E	911	-	4,4,4	0.35	0	6,6,6	0.26	0
4	SO4	E	913	-	4,4,4	0.29	0	6,6,6	0.15	0
5	MLA	H	922	-	6,6,6	1.19	0	7,7,7	1.36	0
3	FRU	C	902	-	11,12,12	0.65	0	10,18,18	1.13	0
5	MLA	D	922	-	6,6,6	1.18	0	7,7,7	1.38	0
4	SO4	B	913	-	4,4,4	0.34	0	6,6,6	0.19	0
2	UDP	G	901	-	25,26,26	1.04	1 (4%)	38,40,40	1.64	6 (15%)
5	MLA	C	921	-	6,6,6	1.16	0	7,7,7	1.51	1 (14%)
4	SO4	E	912	-	4,4,4	0.28	0	6,6,6	0.09	0
3	FRU	A	902	-	11,12,12	0.65	0	10,18,18	1.14	0
4	SO4	G	912	-	4,4,4	0.27	0	6,6,6	0.10	0
4	SO4	C	912	-	4,4,4	0.27	0	6,6,6	0.10	0
2	UDP	C	901	-	25,26,26	1.07	1 (4%)	38,40,40	1.65	6 (15%)
5	MLA	F	922	-	6,6,6	1.17	0	7,7,7	1.35	0
4	SO4	A	915	-	4,4,4	0.26	0	6,6,6	0.09	0
5	MLA	B	921	-	6,6,6	1.34	0	7,7,7	1.13	0

Mol	Type	Chain	Res	Link	Bond lengths			Bond angles		
					Counts	RMSZ	# Z > 2	Counts	RMSZ	# Z > 2
4	SO4	A	914	-	4,4,4	0.28	0	6,6,6	0.09	0
4	SO4	A	911	-	4,4,4	0.29	0	6,6,6	0.27	0
4	SO4	H	912	-	4,4,4	0.28	0	6,6,6	0.10	0
3	FRU	E	902	-	11,12,12	0.78	1 (9%)	10,18,18	1.00	0
3	FRU	F	902	-	11,12,12	0.59	0	10,18,18	1.06	0
4	SO4	B	911	-	4,4,4	0.37	0	6,6,6	0.23	0
4	SO4	D	912	-	4,4,4	0.29	0	6,6,6	0.14	0
5	MLA	E	921	-	6,6,6	1.31	0	7,7,7	1.01	0
5	MLA	G	922	-	6,6,6	1.20	0	7,7,7	1.34	0
4	SO4	A	912	-	4,4,4	0.31	0	6,6,6	0.09	0
2	UDP	E	901	-	25,26,26	1.09	2 (8%)	38,40,40	1.54	6 (15%)
3	FRU	G	902	-	11,12,12	1.11	1 (9%)	10,18,18	1.21	1 (10%)
4	SO4	G	914	-	4,4,4	0.29	0	6,6,6	0.15	0
4	SO4	F	911	-	4,4,4	0.34	0	6,6,6	0.21	0
5	MLA	H	921	-	6,6,6	1.27	0	7,7,7	1.19	0
2	UDP	B	901	-	25,26,26	1.09	2 (8%)	38,40,40	1.46	4 (10%)
2	UDP	F	901	-	25,26,26	1.04	1 (4%)	38,40,40	1.70	7 (18%)
4	SO4	E	914	-	4,4,4	0.30	0	6,6,6	0.15	0
5	MLA	D	921	-	6,6,6	1.18	0	7,7,7	1.38	1 (14%)
2	UDP	H	901	-	25,26,26	1.10	1 (4%)	38,40,40	1.60	6 (15%)
4	SO4	F	912	-	4,4,4	0.29	0	6,6,6	0.10	0
4	SO4	C	911	-	4,4,4	0.30	0	6,6,6	0.19	0
5	MLA	A	921	-	6,6,6	1.18	0	7,7,7	1.34	1 (14%)
3	FRU	D	902	-	11,12,12	0.64	0	10,18,18	0.99	0
4	SO4	H	913	-	4,4,4	0.31	0	6,6,6	0.16	0
4	SO4	G	913	-	4,4,4	0.32	0	6,6,6	0.18	0
4	SO4	B	912	-	4,4,4	0.30	0	6,6,6	0.12	0
4	SO4	F	914	-	4,4,4	0.29	0	6,6,6	0.13	0
5	MLA	F	921	-	6,6,6	1.28	0	7,7,7	1.15	0
4	SO4	C	913	-	4,4,4	0.29	0	6,6,6	0.10	0
4	SO4	D	911	-	4,4,4	0.29	0	6,6,6	0.27	0
4	SO4	D	914	-	4,4,4	0.29	0	6,6,6	0.20	0
4	SO4	F	913	-	4,4,4	0.33	0	6,6,6	0.21	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
5	MLA	G	921	-	-	2/4/4/4	-

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Mol	Type	Chain	Res	Link	Chirals	Torsions	Rings
2	UDP	D	901	-	-	5/16/32/32	0/2/2/2
2	UDP	A	901	-	-	3/16/32/32	0/2/2/2
3	FRU	B	902	-	-	1/5/24/24	0/1/1/1
3	FRU	H	902	-	-	5/5/24/24	0/1/1/1
5	MLA	H	922	-	-	0/4/4/4	-
3	FRU	C	902	-	-	1/5/24/24	0/1/1/1
5	MLA	D	922	-	-	2/4/4/4	-
2	UDP	G	901	-	-	7/16/32/32	0/2/2/2
5	MLA	C	921	-	-	0/4/4/4	-
3	FRU	A	902	-	-	3/5/24/24	0/1/1/1
2	UDP	C	901	-	-	5/16/32/32	0/2/2/2
5	MLA	F	922	-	-	0/4/4/4	-
5	MLA	B	921	-	-	1/4/4/4	-
3	FRU	E	902	-	-	3/5/24/24	0/1/1/1
3	FRU	F	902	-	-	5/5/24/24	0/1/1/1
5	MLA	E	921	-	-	0/4/4/4	-
5	MLA	G	922	-	-	0/4/4/4	-
2	UDP	E	901	-	-	5/16/32/32	0/2/2/2
3	FRU	G	902	-	-	5/5/24/24	0/1/1/1
5	MLA	H	921	-	-	0/4/4/4	-
2	UDP	B	901	-	-	6/16/32/32	0/2/2/2
2	UDP	F	901	-	-	5/16/32/32	0/2/2/2
5	MLA	D	921	-	-	2/4/4/4	-
2	UDP	H	901	-	-	5/16/32/32	0/2/2/2
5	MLA	A	921	-	-	0/4/4/4	-
3	FRU	D	902	-	-	4/5/24/24	0/1/1/1
5	MLA	F	921	-	-	0/4/4/4	-

The worst 5 of 12 bond length outliers are listed below:

Mol	Chain	Res	Type	Atoms	Z	Observed(Å)	Ideal(Å)
2	C	901	UDP	PA-O3A	2.98	1.62	1.59
2	B	901	UDP	PA-O3A	2.86	1.62	1.59
3	G	902	FRU	O5-C2	-2.65	1.39	1.43
2	F	901	UDP	PA-O3A	2.64	1.62	1.59
2	H	901	UDP	PA-O3A	2.51	1.62	1.59

The worst 5 of 50 bond angle outliers are listed below:

Mol	Chain	Res	Type	Atoms	Z	Observed(°)	Ideal(°)
2	F	901	UDP	C4-N3-C2	-6.02	119.14	126.61
2	G	901	UDP	C4-N3-C2	-5.95	119.23	126.61
2	C	901	UDP	C4-N3-C2	-5.83	119.38	126.61
2	D	901	UDP	C4-N3-C2	-5.82	119.38	126.61
2	H	901	UDP	C4-N3-C2	-5.65	119.60	126.61

There are no chirality outliers.

5 of 75 torsion outliers are listed below:

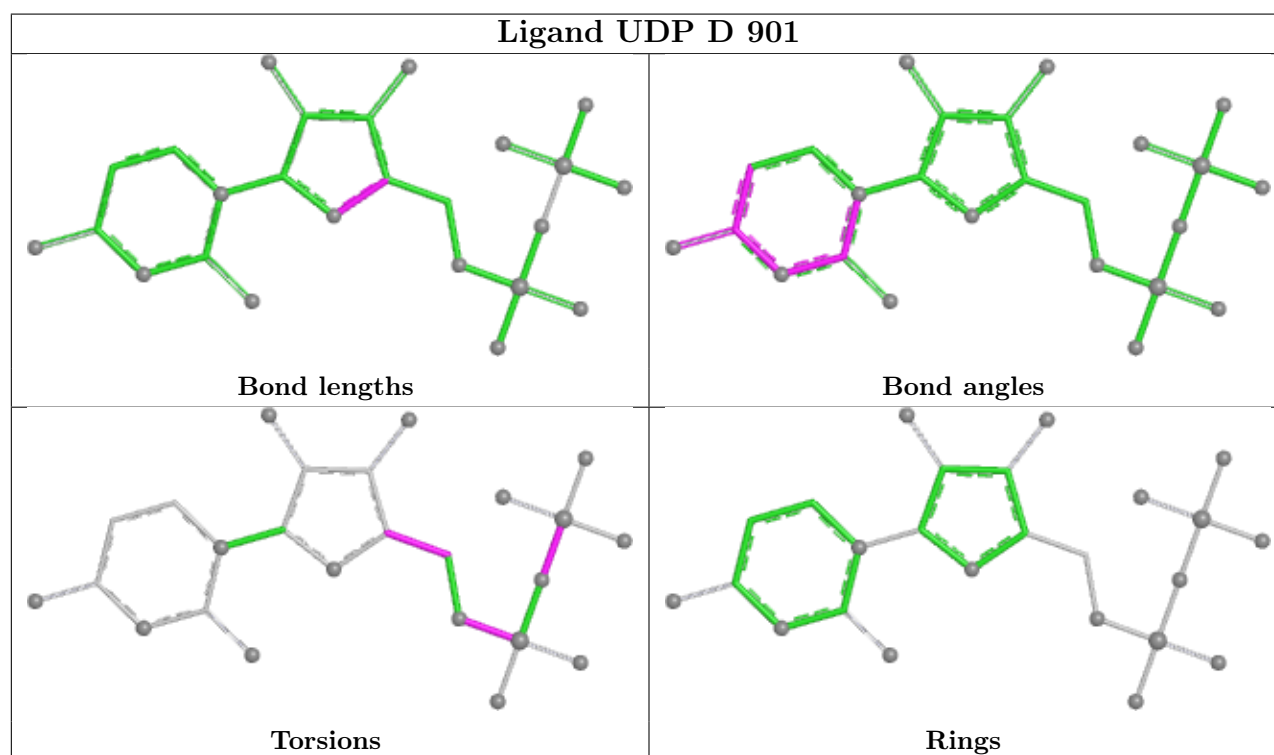
Mol	Chain	Res	Type	Atoms
2	B	901	UDP	PA-O3A-PB-O2B
2	B	901	UDP	PA-O3A-PB-O3B
2	C	901	UDP	PA-O3A-PB-O2B
2	C	901	UDP	PA-O3A-PB-O3B
2	D	901	UDP	C5'-O5'-PA-O1A

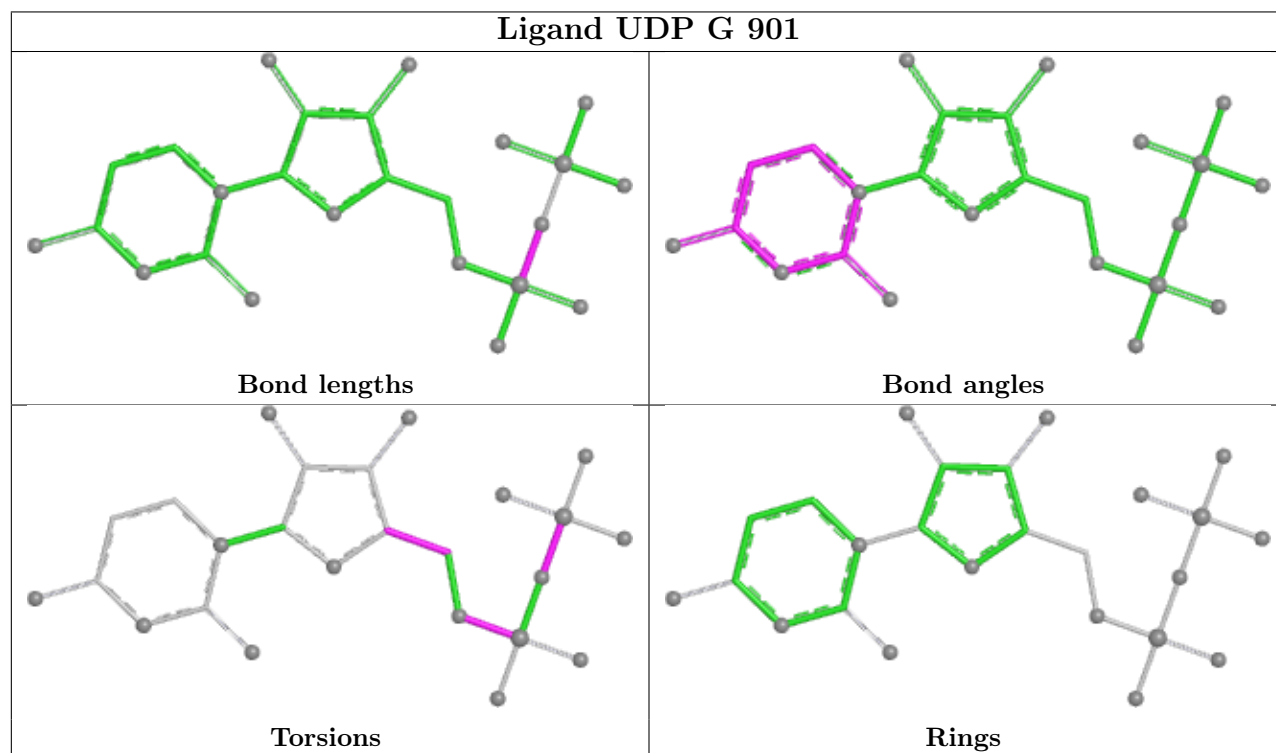
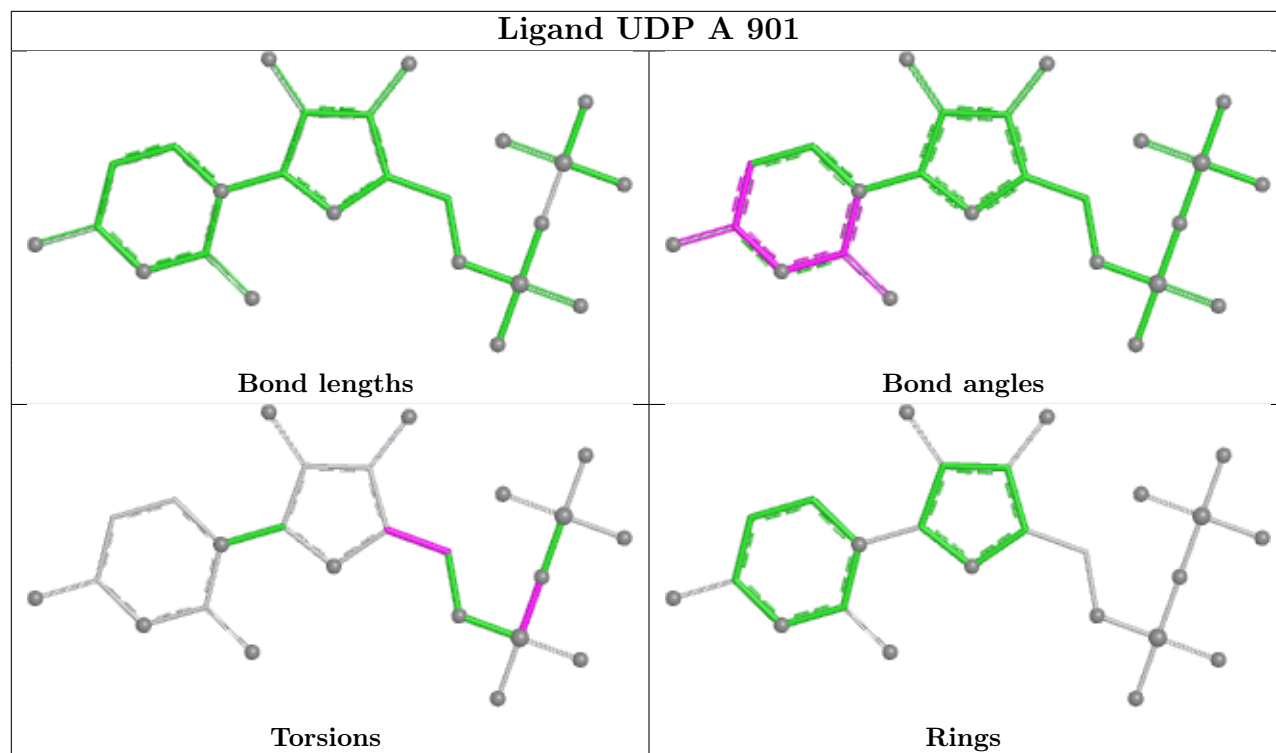
There are no ring outliers.

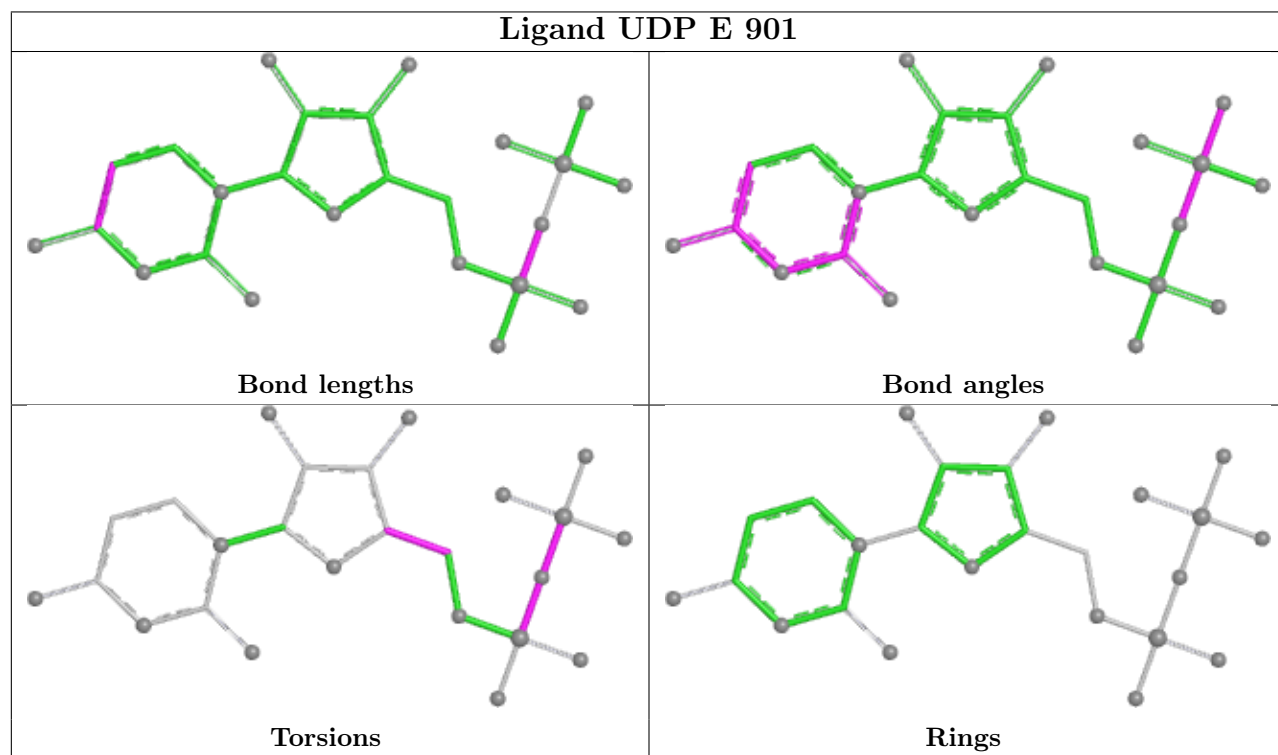
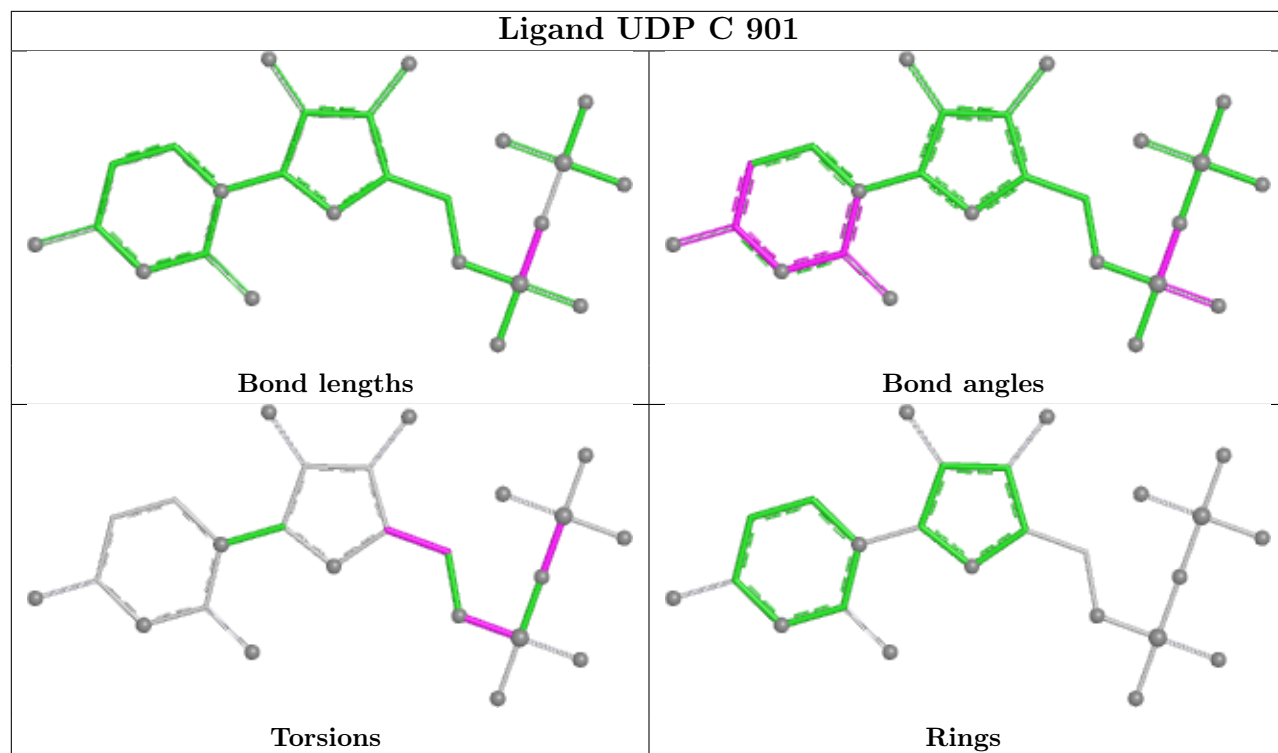
22 monomers are involved in 53 short contacts:

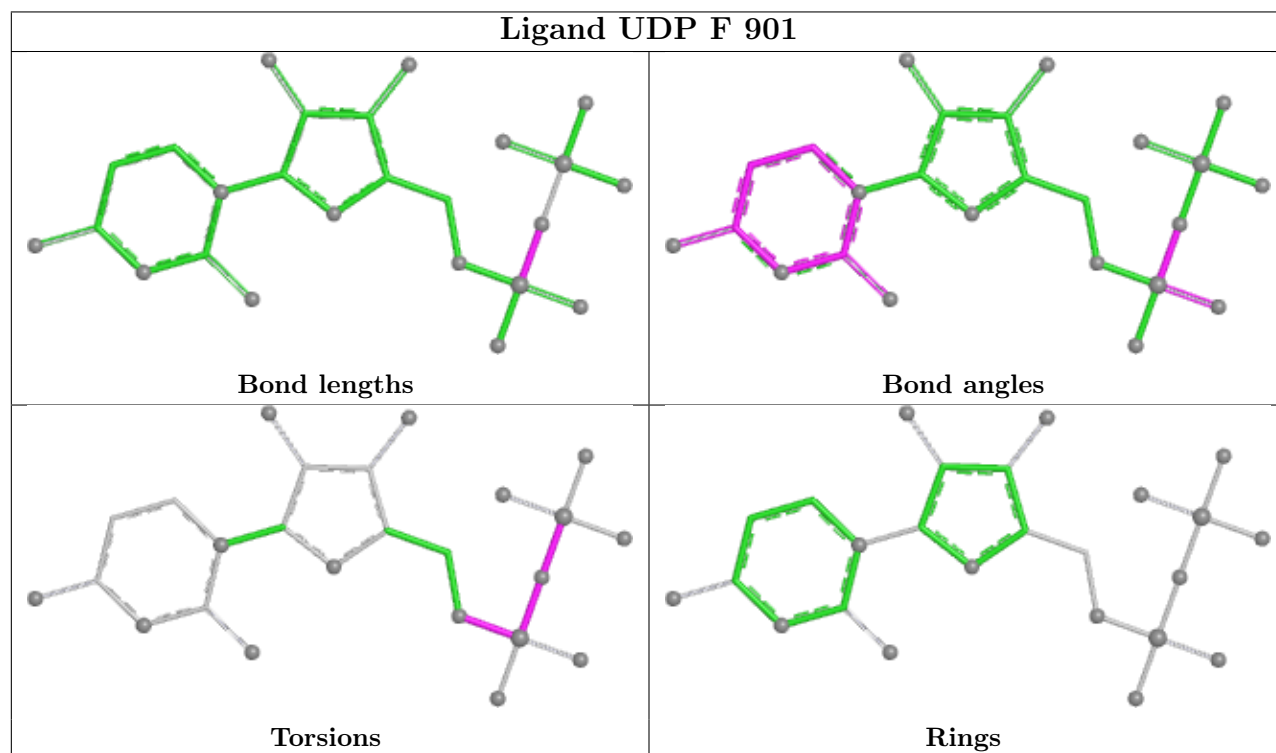
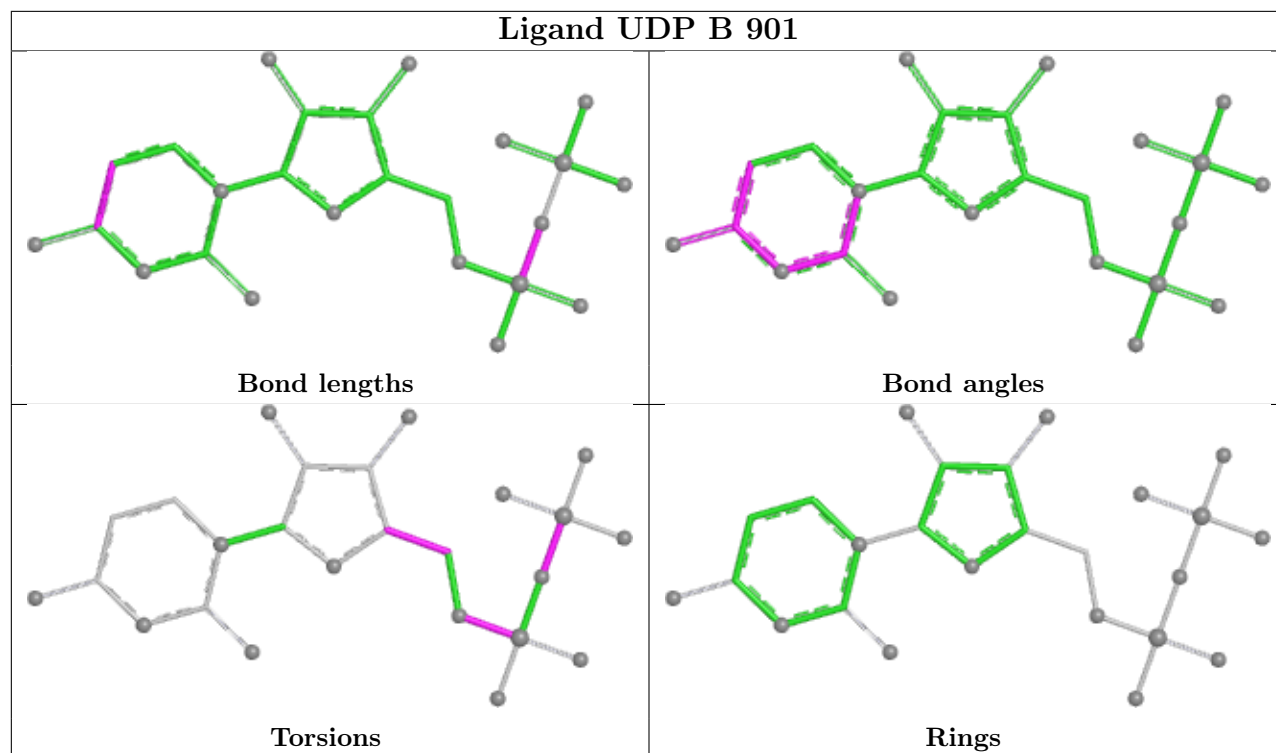
Mol	Chain	Res	Type	Clashes	Symm-Clashes
4	A	913	SO4	1	0
2	A	901	UDP	1	0
3	B	902	FRU	6	0
3	H	902	FRU	1	0
4	D	913	SO4	1	0
4	E	913	SO4	2	0
5	H	922	MLA	1	0
3	C	902	FRU	4	0
5	D	922	MLA	1	0
4	B	913	SO4	3	0
2	G	901	UDP	1	0
4	E	912	SO4	1	0
3	A	902	FRU	8	0
5	F	922	MLA	2	0
3	E	902	FRU	12	0
4	A	912	SO4	1	0
2	E	901	UDP	1	0
2	B	901	UDP	2	0
2	F	901	UDP	1	0
4	E	914	SO4	1	0
5	D	921	MLA	1	0
4	G	913	SO4	1	0

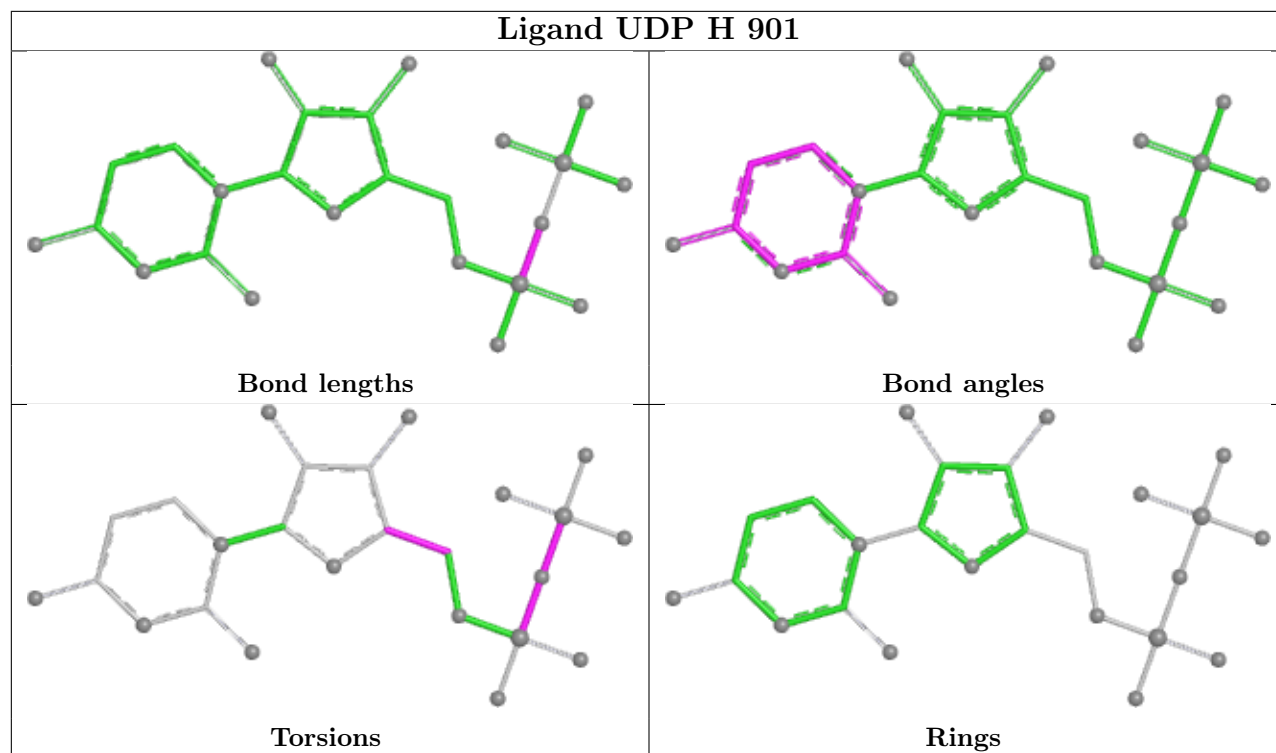
The following is a two-dimensional graphical depiction of Mogul quality analysis of bond lengths, bond angles, torsion angles, and ring geometry for all instances of the Ligand of Interest. In addition, ligands with molecular weight > 250 and outliers as shown on the validation Tables will also be included. 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 [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	781/816 (95%)	-0.42	27 (3%) 47 37	21, 36, 99, 130	0
1	B	791/816 (96%)	-0.24	48 (6%) 27 20	24, 40, 108, 139	0
1	C	781/816 (95%)	-0.37	20 (2%) 57 48	27, 42, 89, 121	0
1	D	781/816 (95%)	-0.44	21 (2%) 56 47	23, 36, 89, 123	0
1	E	781/816 (95%)	-0.39	27 (3%) 47 37	22, 38, 109, 142	0
1	F	781/816 (95%)	-0.44	18 (2%) 61 52	21, 36, 85, 126	0
1	G	781/816 (95%)	-0.47	11 (1%) 73 67	22, 38, 83, 115	0
1	H	797/816 (97%)	-0.32	31 (3%) 43 34	24, 41, 94, 137	0
All	All	6274/6528 (96%)	-0.38	203 (3%) 50 41	21, 39, 94, 142	0

The worst 5 of 203 RSRZ outliers are listed below:

Mol	Chain	Res	Type	RSRZ
1	B	104	LEU	5.0
1	B	128	VAL	4.8
1	H	128	VAL	4.7
1	B	68	PRO	4.6
1	H	104	LEU	4.5

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 ⓘ

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
4	SO4	A	915	5/5	0.63	0.12	120,122,135,138	0
4	SO4	E	914	5/5	0.72	0.20	65,88,93,106	0
4	SO4	G	914	5/5	0.72	0.20	62,88,97,108	0
4	SO4	A	914	5/5	0.73	0.17	59,91,102,108	0
4	SO4	F	914	5/5	0.76	0.16	59,81,101,102	0
5	MLA	F	922	7/7	0.78	0.21	49,58,70,70	0
4	SO4	H	913	5/5	0.79	0.23	70,78,93,114	0
4	SO4	D	914	5/5	0.79	0.16	64,90,95,108	0
5	MLA	H	922	7/7	0.81	0.13	70,79,84,85	0
6	K	B	931	1/1	0.81	0.10	99,99,99,99	0
4	SO4	C	912	5/5	0.82	0.20	73,82,95,107	0
4	SO4	H	912	5/5	0.82	0.25	66,89,99,112	0
4	SO4	B	912	5/5	0.82	0.17	76,85,96,114	0
4	SO4	B	913	5/5	0.83	0.32	63,74,83,102	0
5	MLA	G	922	7/7	0.83	0.09	69,86,100,100	0
4	SO4	A	912	5/5	0.85	0.18	62,72,79,100	0
4	SO4	D	912	5/5	0.87	0.18	57,71,94,108	0
4	SO4	F	911	5/5	0.88	0.27	51,51,80,90	0
4	SO4	A	913	5/5	0.88	0.22	49,66,79,86	0
4	SO4	D	913	5/5	0.88	0.22	58,60,73,85	0
4	SO4	E	912	5/5	0.89	0.19	65,77,86,100	0
4	SO4	D	911	5/5	0.90	0.21	47,64,79,95	0
4	SO4	G	912	5/5	0.90	0.19	57,74,84,97	0
4	SO4	E	913	5/5	0.90	0.21	54,57,84,92	0
6	K	E	931	1/1	0.90	0.10	79,79,79,79	0
4	SO4	B	911	5/5	0.91	0.18	53,57,72,97	0
4	SO4	C	911	5/5	0.91	0.19	51,51,71,82	0
4	SO4	H	911	5/5	0.91	0.21	47,48,81,82	0
4	SO4	F	913	5/5	0.91	0.20	53,56,74,79	0
6	K	C	931	1/1	0.91	0.09	75,75,75,75	0
4	SO4	A	911	5/5	0.91	0.26	46,48,79,82	0
4	SO4	F	912	5/5	0.92	0.17	57,71,79,92	0
4	SO4	E	911	5/5	0.92	0.19	44,44,71,79	0
5	MLA	C	921	7/7	0.92	0.13	58,61,72,72	0
6	K	G	931	1/1	0.92	0.14	76,76,76,76	0
3	FRU	C	902	12/12	0.93	0.10	31,38,43,46	0
5	MLA	D	922	7/7	0.93	0.15	45,49,54,55	0

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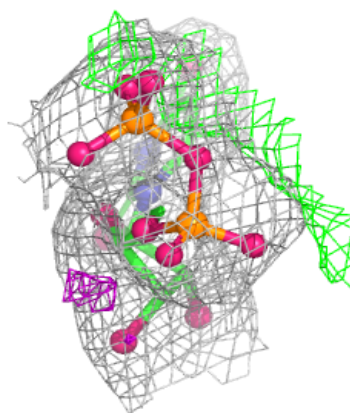
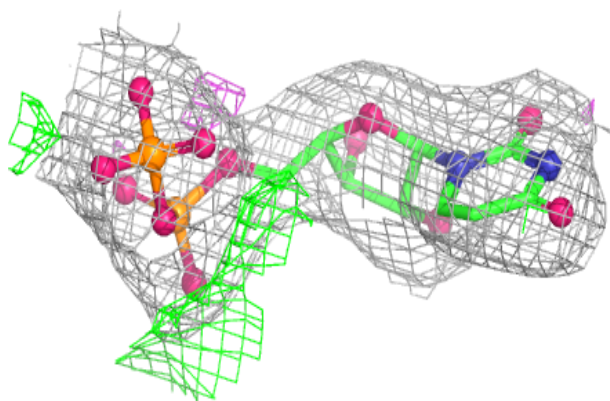
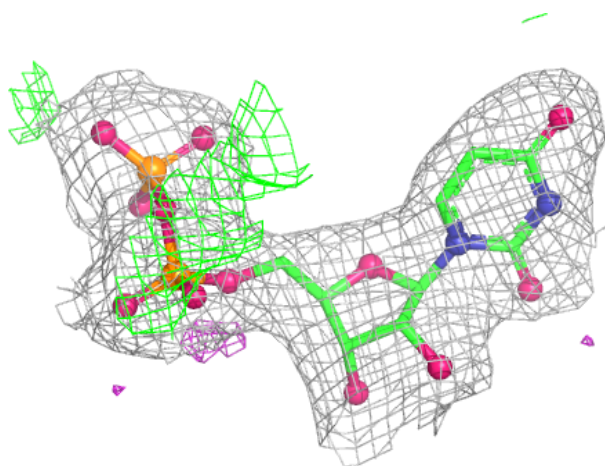
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Mol	Type	Chain	Res	Atoms	RSCC	RSR	B-factors($\text{\AA}^2$)	Q<0.9
5	MLA	E	921	7/7	0.93	0.11	36,45,50,54	0
4	SO4	G	913	5/5	0.93	0.18	58,62,82,92	0
6	K	F	931	1/1	0.93	0.12	89,89,89,89	0
4	SO4	C	913	5/5	0.93	0.17	64,68,88,94	0
4	SO4	G	911	5/5	0.94	0.20	41,44,65,67	0
3	FRU	G	902	12/12	0.94	0.10	24,33,34,39	0
5	MLA	D	921	7/7	0.94	0.12	37,44,46,48	0
5	MLA	H	921	7/7	0.94	0.12	47,56,67,67	0
3	FRU	A	902	12/12	0.94	0.09	28,29,32,34	0
6	K	H	931	1/1	0.94	0.09	74,74,74,74	0
6	K	D	931	1/1	0.95	0.14	81,81,81,81	0
5	MLA	G	921	7/7	0.95	0.14	52,59,71,71	0
6	K	A	931	1/1	0.95	0.08	72,72,72,72	0
3	FRU	H	902	12/12	0.95	0.09	23,29,34,36	0
3	FRU	B	902	12/12	0.95	0.09	27,30,33,33	0
5	MLA	B	921	7/7	0.96	0.08	45,48,58,58	0
5	MLA	F	921	7/7	0.96	0.14	32,38,40,45	0
3	FRU	E	902	12/12	0.96	0.07	28,30,33,33	0
5	MLA	A	921	7/7	0.97	0.10	38,41,49,49	0
2	UDP	E	901	25/25	0.98	0.05	23,26,31,33	0
3	FRU	F	902	12/12	0.98	0.05	23,26,28,28	0
2	UDP	B	901	25/25	0.98	0.04	25,29,32,32	0
2	UDP	C	901	25/25	0.98	0.05	25,31,35,39	0
2	UDP	D	901	25/25	0.98	0.04	22,25,32,35	0
3	FRU	D	902	12/12	0.98	0.06	25,28,32,32	0
2	UDP	G	901	25/25	0.99	0.04	19,26,29,31	0
2	UDP	H	901	25/25	0.99	0.04	25,28,34,37	0
2	UDP	A	901	25/25	0.99	0.04	20,26,29,33	0
2	UDP	F	901	25/25	0.99	0.04	18,25,29,33	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.

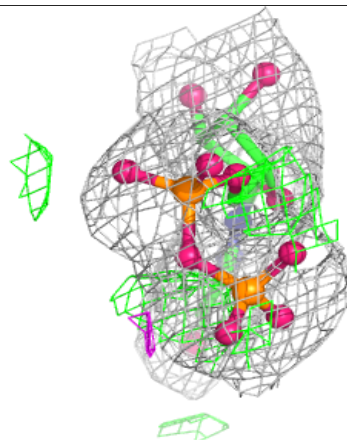
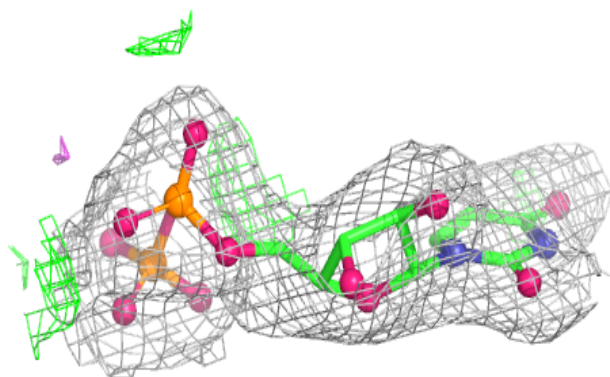
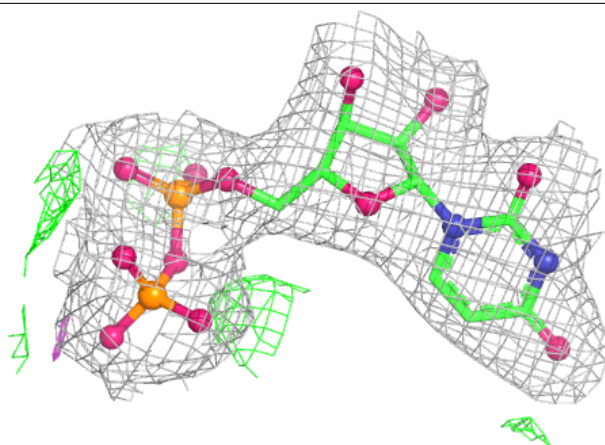
Electron density around UDP E 901:

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



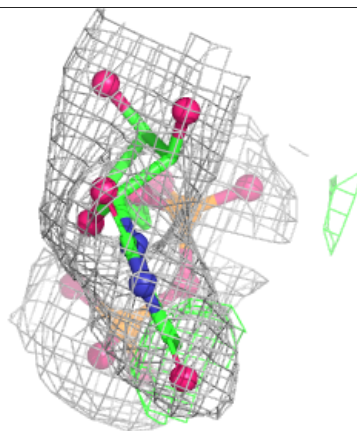
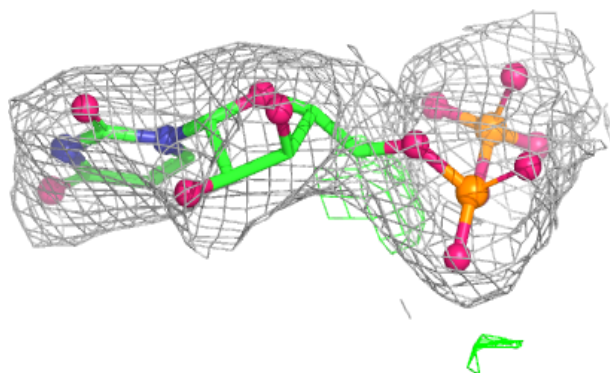
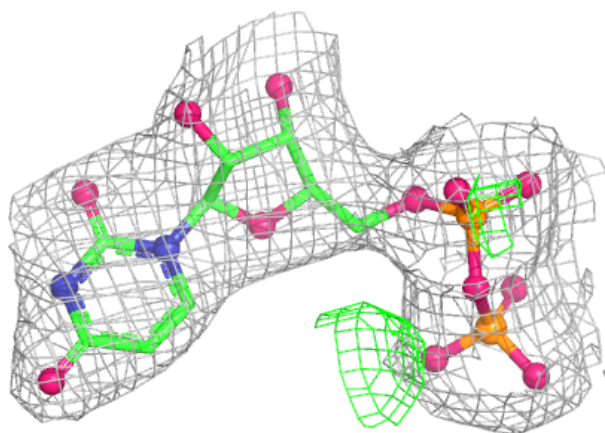
Electron density around UDP B 901:

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



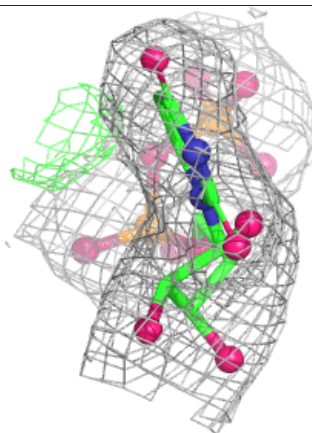
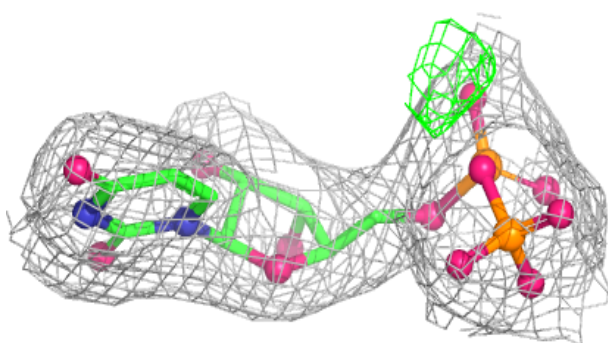
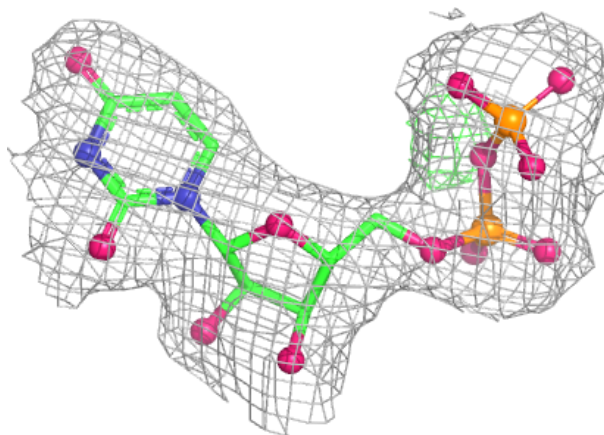
Electron density around UDP C 901:

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

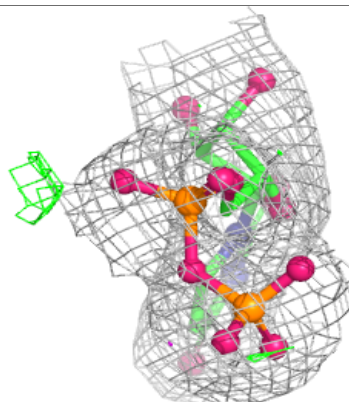
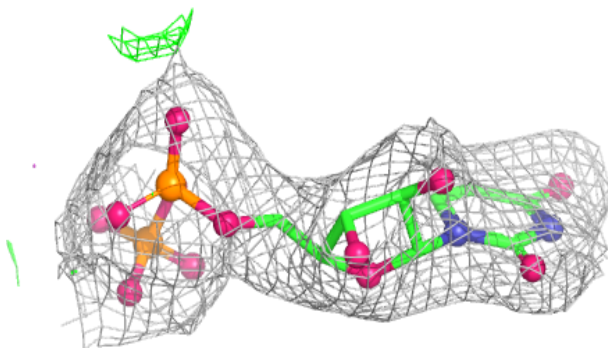
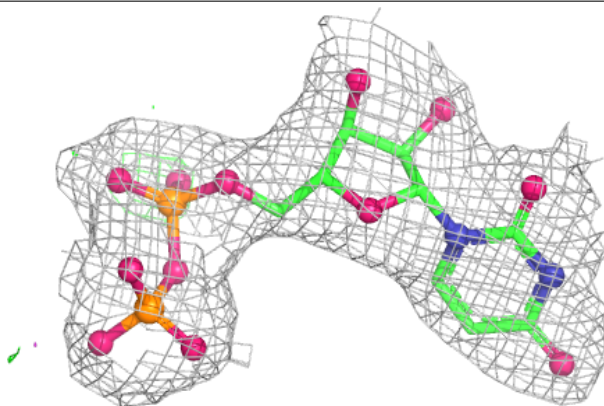


Electron density around UDP D 901:

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 mF_o-DF_c (at 3 rmsd) in purple (negative)
and green (positive)

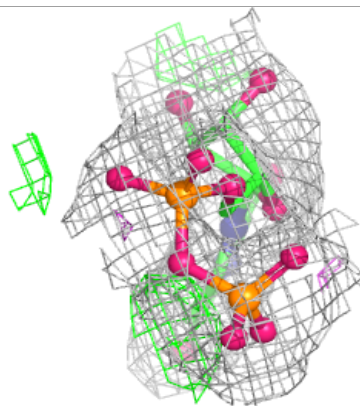
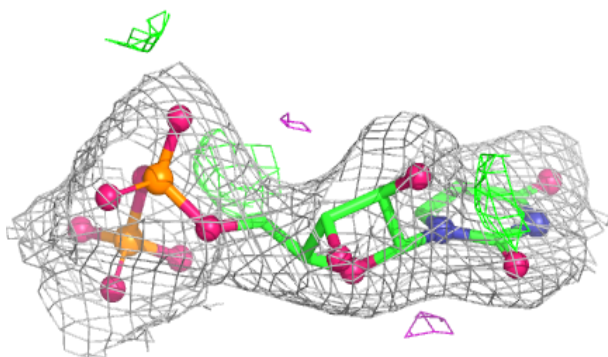
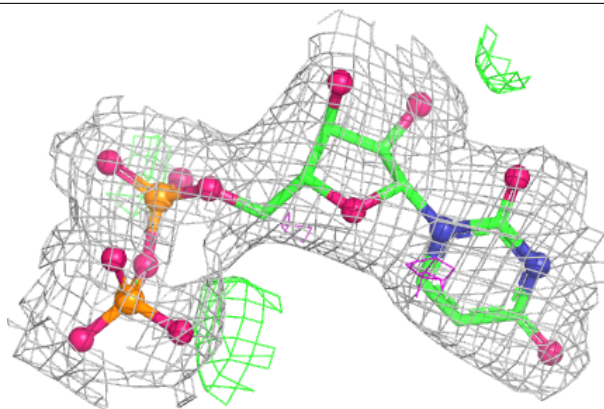
**Electron density around UDP G 901:**

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 mF_o-DF_c (at 3 rmsd) in purple (negative)
and green (positive)



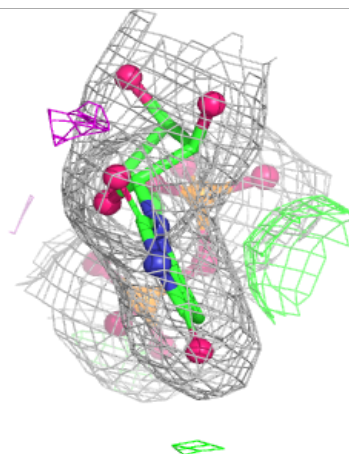
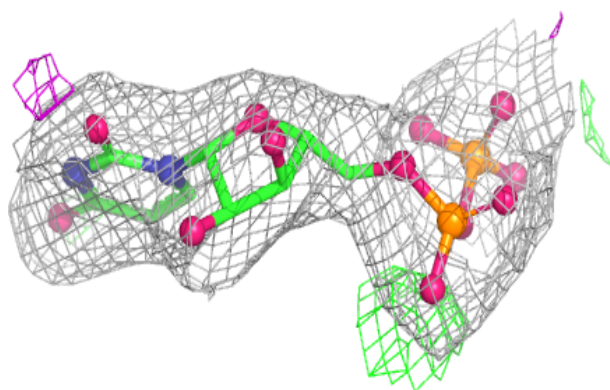
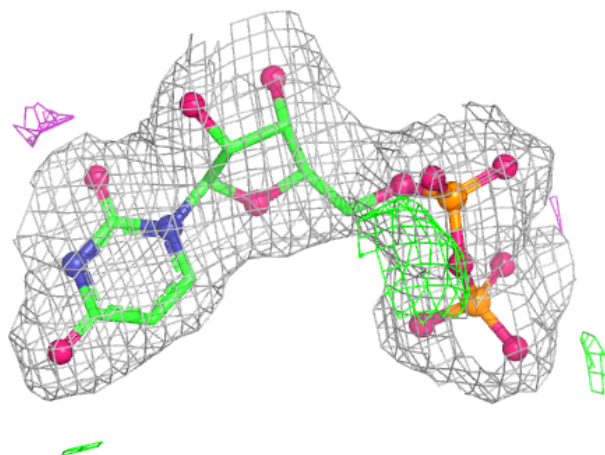
Electron density around UDP H 901:

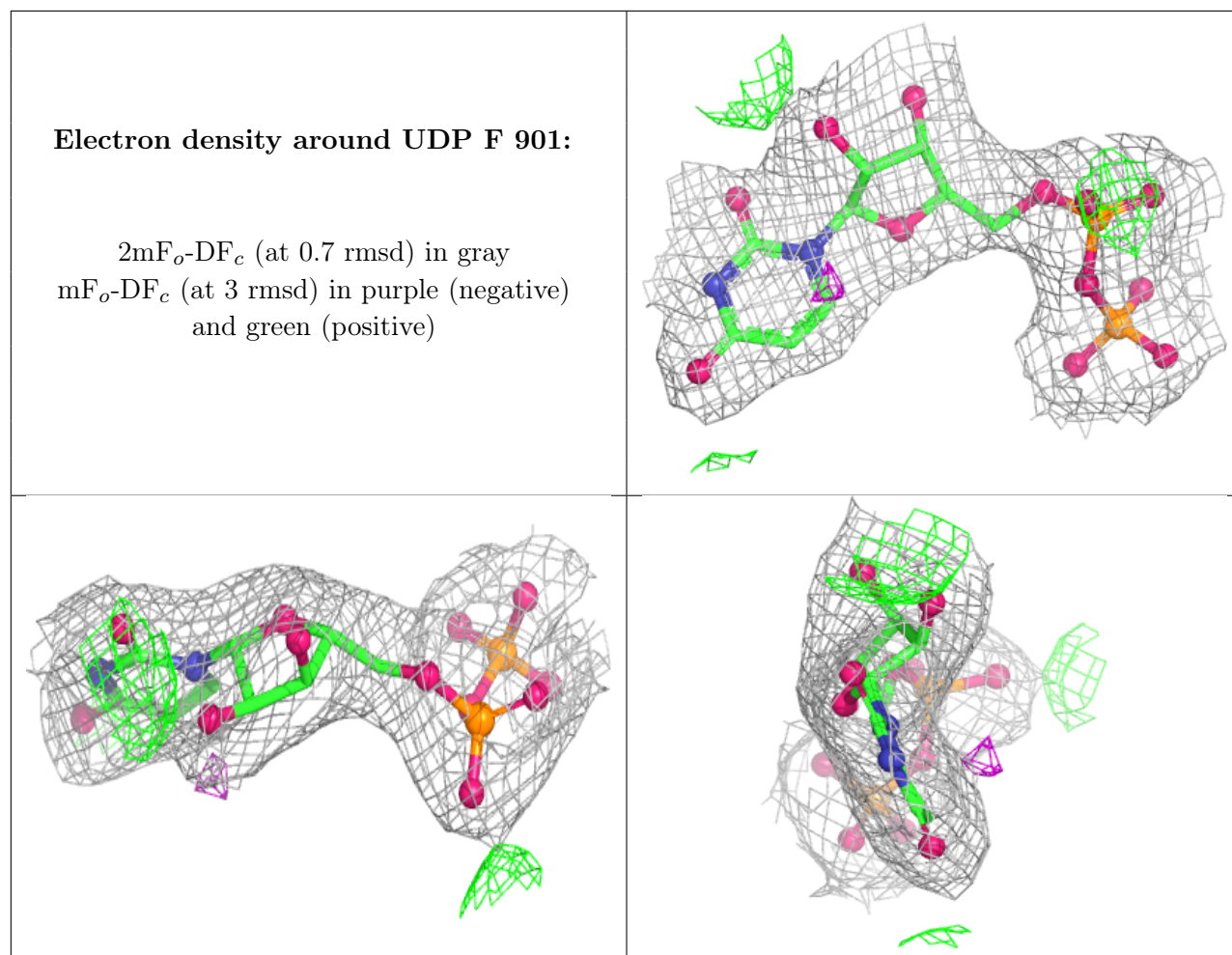
$2mF_o-DF_c$ (at 0.7 rmsd) in gray
 mF_o-DF_c (at 3 rmsd) in purple (negative)
and green (positive)



Electron density around UDP A 901:

$2mF_o-DF_c$ (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.