



Full wwPDB X-ray Structure Validation Report ⓘ

Mar 5, 2026 – 01:42 AM UTC

PDB ID : 8P6S / pdb_00008p6s
Title : Arabidopsis thaliana DGD2 in complex with UDP-galactose
Authors : Scaletti, E.R.; Martinez-Carranza, M.; Stenmark, P.
Deposited on : 2023-05-29
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

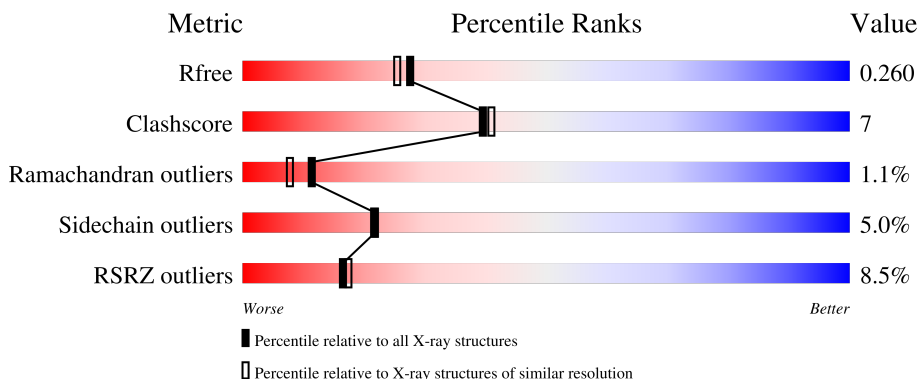
1 Overall quality at a glance

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	412	

2 Entry composition

There are 3 unique types of molecules in this entry. The entry contains 3033 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.

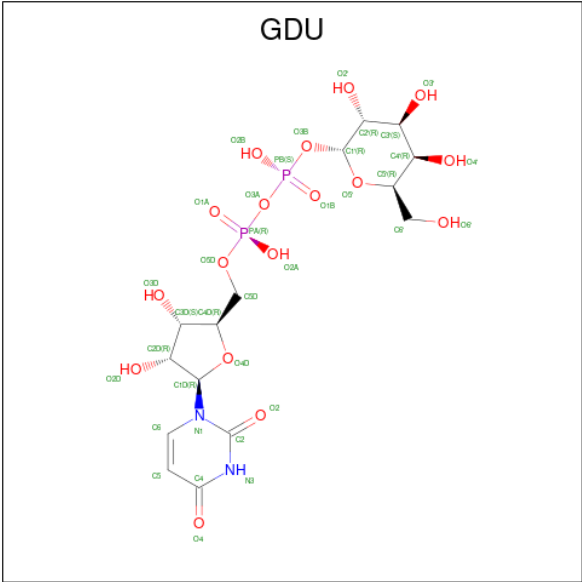
- Molecule 1 is a protein called Digalactosyldiacylglycerol synthase 2, chloroplastic.

Mol	Chain	Residues	Atoms					ZeroOcc	AltConf	Trace
1	A	376	Total	C	N	O	S	0	0	0
			2937	1888	504	538	7			

There are 12 discrepancies between the modelled and reference sequences:

Chain	Residue	Modelled	Actual	Comment	Reference
A	401	LYS	-	expression tag	UNP Q8W1S1
A	402	LEU	-	expression tag	UNP Q8W1S1
A	403	ALA	-	expression tag	UNP Q8W1S1
A	404	ALA	-	expression tag	UNP Q8W1S1
A	405	HIS	-	expression tag	UNP Q8W1S1
A	406	HIS	-	expression tag	UNP Q8W1S1
A	407	HIS	-	expression tag	UNP Q8W1S1
A	408	HIS	-	expression tag	UNP Q8W1S1
A	409	HIS	-	expression tag	UNP Q8W1S1
A	410	HIS	-	expression tag	UNP Q8W1S1
A	411	HIS	-	expression tag	UNP Q8W1S1
A	412	HIS	-	expression tag	UNP Q8W1S1

- Molecule 2 is GALACTOSE-URIDINE-5'-DIPHOSPHATE (CCD ID: GDU) (formula: C₁₅H₂₄N₂O₁₇P₂) (labeled as "Ligand of Interest" by depositor).



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

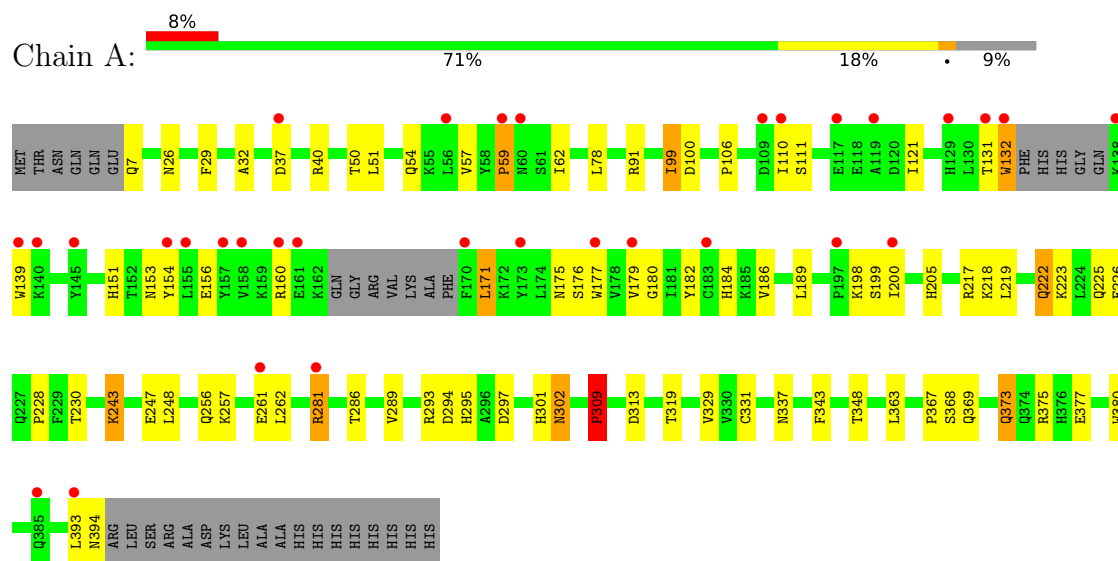
- Molecule 3 is water.

Mol	Chain	Residues	Atoms	ZeroOcc	AltConf
3	A	60	Total	0	0
			60 O 60 60		

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: Digalactosyldiacylglycerol synthase 2, chloroplastic



4 Data and refinement statistics

Property	Value	Source
Space group	P 41 21 2	Depositor
Cell constants a, b, c, α , β , γ	44.03Å 44.03Å 368.48Å 90.00° 90.00° 90.00°	Depositor
Resolution (Å)	92.29 – 2.10 92.12 – 2.10	Depositor EDS
% Data completeness (in resolution range)	98.1 (92.29-2.10) 98.2 (92.12-2.10)	Depositor EDS
R_{merge}	(Not available)	Depositor
R_{sym}	(Not available)	Depositor
$\langle I/\sigma(I) \rangle$ ¹	1.92 (at 2.10Å)	Xtriage
Refinement program	REFMAC 5.8.0411	Depositor
R, R_{free}	0.203 , 0.257 0.212 , 0.260	Depositor DCC
R_{free} test set	1154 reflections (5.09%)	wwPDB-VP
Wilson B-factor (Å ²)	44.1	Xtriage
Anisotropy	0.070	Xtriage
Bulk solvent k_{sol} (e/Å ³), B_{sol} (Å ²)	0.36 , 65.9	EDS
L-test for twinning ²	$\langle L \rangle = 0.53$, $\langle L^2 \rangle = 0.38$	Xtriage
Estimated twinning fraction	No twinning to report.	Xtriage
F_o, F_c correlation	0.95	EDS
Total number of atoms	3033	wwPDB-VP
Average B, all atoms (Å ²)	57.0	wwPDB-VP

Xtriage's analysis on translational NCS is as follows: *The largest off-origin peak in the Patterson function is 4.87% 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: GDU

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	0.94	3/3006 (0.1%)	1.41	16/4086 (0.4%)

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	6

All (3) bond length outliers are listed below:

Mol	Chain	Res	Type	Atoms	Z	Observed(Å)	Ideal(Å)
1	A	297	ASP	CG-OD1	-6.95	1.12	1.25
1	A	289	VAL	C-O	-5.65	1.18	1.24
1	A	295	HIS	CE1-NE2	5.09	1.37	1.32

All (16) bond angle outliers are listed below:

Mol	Chain	Res	Type	Atoms	Z	Observed(°)	Ideal(°)
1	A	184	HIS	N-CA-C	-7.03	103.69	111.36
1	A	394	ASN	CA-CB-CG	-6.90	105.70	112.60
1	A	222	GLN	CB-CA-C	-6.81	100.19	110.88
1	A	367	PRO	N-CA-C	-6.50	101.04	111.38
1	A	302	ASN	CB-CA-C	-6.46	99.24	110.17
1	A	343	PHE	CB-CA-C	6.44	117.23	109.31
1	A	26	ASN	CA-CB-CG	-6.15	106.45	112.60
1	A	309	PRO	N-CA-CB	-6.07	96.87	103.25
1	A	337	ASN	CA-CB-CG	-6.04	106.56	112.60
1	A	281	ARG	CB-CA-C	6.00	121.51	110.11

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Mol	Chain	Res	Type	Atoms	Z	Observed(°)	Ideal(°)
1	A	184	HIS	CB-CA-C	5.80	120.71	110.85
1	A	301	HIS	CA-CB-CG	-5.33	108.47	113.80
1	A	294	ASP	CA-CB-CG	5.29	117.89	112.60
1	A	286	THR	CA-CB-OG1	-5.12	101.91	109.60
1	A	243	LYS	CA-C-N	-5.07	117.40	123.44
1	A	243	LYS	C-N-CA	-5.07	117.40	123.44

There are no chirality outliers.

All (6) planarity outliers are listed below:

Mol	Chain	Res	Type	Group
1	A	160	ARG	Sidechain
1	A	171	LEU	Peptide
1	A	281	ARG	Sidechain
1	A	293	ARG	Sidechain
1	A	375	ARG	Sidechain
1	A	91	ARG	Sidechain

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	2937	0	2837	39	0
2	A	36	0	22	1	0
3	A	60	0	0	2	0
All	All	3033	0	2859	39	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 7.

All (39) 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:373:GLN:HE21	1:A:373:GLN:H	1.27	0.81
1:A:248:LEU:HB2	1:A:309:PRO:HG3	1.67	0.76

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Atom-1	Atom-2	Interatomic distance (Å)	Clash overlap (Å)
1:A:175:ASN:O	1:A:179:VAL:HG23	1.92	0.69
1:A:7:GLN:HE21	1:A:40:ARG:HG3	1.59	0.66
1:A:99:ILE:HD12	1:A:99:ILE:H	1.61	0.66
1:A:7:GLN:HE22	1:A:40:ARG:HH21	1.43	0.65
1:A:59:PRO:O	1:A:62:ILE:N	2.23	0.65
1:A:226:GLU:O	3:A:601:HOH:O	2.13	0.65
1:A:319:THR:HG23	1:A:329:VAL:HG11	1.84	0.60
1:A:121:ILE:HD13	1:A:393:LEU:HD21	1.86	0.58
1:A:313:ASP:OD1	2:A:501:GDU:H3'	2.03	0.58
1:A:100:ASP:OD1	1:A:100:ASP:N	2.40	0.55
1:A:121:ILE:HD13	1:A:393:LEU:CD2	2.36	0.55
1:A:262:LEU:HD13	1:A:363:LEU:HD11	1.89	0.55
1:A:151:HIS:HA	1:A:189:LEU:HD12	1.91	0.53
1:A:331:CYS:O	1:A:348:THR:HA	2.09	0.52
1:A:373:GLN:HE21	1:A:373:GLN:N	2.03	0.52
1:A:7:GLN:NE2	1:A:40:ARG:HH21	2.09	0.51
1:A:186:VAL:O	1:A:199:SER:HA	2.11	0.50
1:A:99:ILE:HD12	1:A:99:ILE:N	2.27	0.50
1:A:189:LEU:HD11	1:A:205:HIS:CE1	2.47	0.49
1:A:373:GLN:O	1:A:377:GLU:HG2	2.12	0.49
1:A:131:THR:O	1:A:132:TRP:C	2.56	0.49
1:A:222:GLN:HG2	1:A:228:PRO:HG2	1.97	0.46
1:A:225:GLN:HA	3:A:601:HOH:O	2.15	0.45
1:A:262:LEU:CD1	1:A:363:LEU:HD11	2.45	0.45
1:A:243:LYS:HG3	1:A:243:LYS:O	2.16	0.45
1:A:225:GLN:C	1:A:226:GLU:O	2.56	0.44
1:A:50:THR:O	1:A:54:GLN:HG3	2.18	0.43
1:A:219:LEU:HG	1:A:223:LYS:HE3	2.00	0.43
1:A:106:PRO:HB3	1:A:110:ILE:CG2	2.50	0.41
1:A:32:ALA:HB2	1:A:78:LEU:HD21	2.03	0.41
1:A:29:PHE:HB3	1:A:380:TRP:CE2	2.55	0.41
1:A:153:ASN:O	1:A:156:GLU:N	2.47	0.41
1:A:176:SER:OG	1:A:177:TRP:N	2.53	0.41
1:A:139:TRP:HB2	1:A:182:TYR:CD1	2.55	0.41
1:A:257:LYS:HD3	1:A:257:LYS:HA	1.96	0.41
1:A:218:LYS:NZ	1:A:302:ASN:OD1	2.28	0.41
1:A:180:GLY:O	1:A:198:LYS:NZ	2.54	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	370/412 (90%)	342 (92%)	24 (6%)	4 (1%)	11 8

All (4) Ramachandran outliers are listed below:

Mol	Chain	Res	Type
1	A	37	ASP
1	A	154	TYR
1	A	171	LEU
1	A	59	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	301/361 (83%)	286 (95%)	15 (5%)	22 22

All (15) residues with a non-rotameric sidechain are listed below:

Mol	Chain	Res	Type
1	A	51	LEU
1	A	57	VAL
1	A	99	ILE
1	A	111	SER
1	A	132	TRP
1	A	200	ILE
1	A	217	ARG

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Mol	Chain	Res	Type
1	A	230	THR
1	A	247	GLU
1	A	256	GLN
1	A	261	GLU
1	A	309	PRO
1	A	368	SER
1	A	369	GLN
1	A	373	GLN

Sometimes sidechains can be flipped to improve hydrogen bonding and reduce clashes. All (2) such sidechains are listed below:

Mol	Chain	Res	Type
1	A	7	GLN
1	A	373	GLN

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](#)

1 ligand is modelled in this entry.

In the following table, the Counts columns list the number of bonds (or angles) for which Mogul statistics could be retrieved, the number of bonds (or angles) that are observed in the model and the number of bonds (or angles) that are defined in the Chemical Component Dictionary. The Link column lists molecule types, if any, to which the group is linked. The Z score for a bond length (or angle) is the number of standard deviations the observed value is removed from the expected value. A bond length (or angle) with $|Z| > 2$ is considered an outlier worth inspection. RMSZ is the root-mean-square of all Z scores of the bond lengths (or angles).

Mol	Type	Chain	Res	Link	Bond lengths			Bond angles		
					Counts	RMSZ	# Z > 2	Counts	RMSZ	# Z > 2
2	GDU	A	501	-	37,38,38	1.29	6 (16%)	55,58,58	1.98	10 (18%)

In the following table, the Chirals column lists the number of chiral outliers, the number of chiral centers analysed, the number of these observed in the model and the number defined in the Chemical Component Dictionary. Similar counts are reported in the Torsion and Rings columns. '-' means no outliers of that kind were identified.

Mol	Type	Chain	Res	Link	Chirals	Torsions	Rings
2	GDU	A	501	-	-	2/23/59/59	0/3/3/3

All (6) bond length outliers are listed below:

Mol	Chain	Res	Type	Atoms	Z	Observed(Å)	Ideal(Å)
2	A	501	GDU	C3'-C2'	3.26	1.60	1.52
2	A	501	GDU	C4'-C5'	3.24	1.59	1.53
2	A	501	GDU	PB-O3A	2.55	1.62	1.59
2	A	501	GDU	O6'-C6'	2.27	1.52	1.42
2	A	501	GDU	C4'-C3'	2.13	1.57	1.52
2	A	501	GDU	O3'-C3'	2.10	1.48	1.43

All (10) bond angle outliers are listed below:

Mol	Chain	Res	Type	Atoms	Z	Observed(°)	Ideal(°)
2	A	501	GDU	O5'-C1'-O3B	6.40	119.73	111.36
2	A	501	GDU	O5'-C1'-C2'	-5.50	99.06	110.37
2	A	501	GDU	O2B-PB-O3A	-5.42	92.63	107.27
2	A	501	GDU	O3B-C1'-C2'	5.20	117.91	108.38
2	A	501	GDU	O2B-PB-O3B	4.72	125.92	106.70
2	A	501	GDU	O2A-PA-O1A	3.35	128.04	112.44
2	A	501	GDU	C3'-C4'-C5'	3.31	116.24	110.23
2	A	501	GDU	O2'-C2'-C3'	3.06	117.59	110.38
2	A	501	GDU	C6'-C5'-C4'	2.51	119.19	113.02
2	A	501	GDU	C4'-C3'-C2'	2.40	115.05	110.83

There are no chirality outliers.

All (2) torsion outliers are listed below:

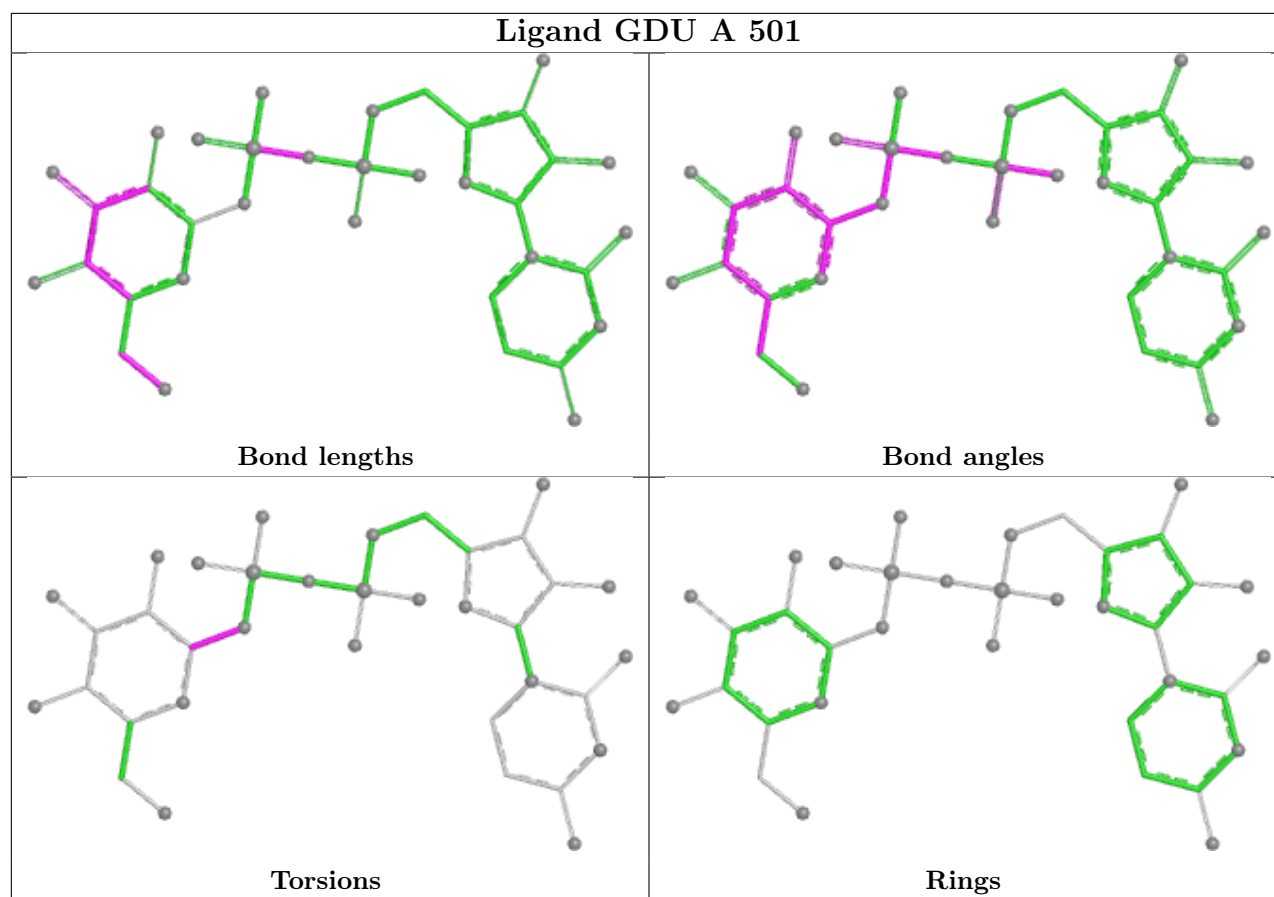
Mol	Chain	Res	Type	Atoms
2	A	501	GDU	C2'-C1'-O3B-PB
2	A	501	GDU	O5'-C1'-O3B-PB

There are no ring outliers.

1 monomer is involved in 1 short contact:

Mol	Chain	Res	Type	Clashes	Symm-Clashes
2	A	501	GDU	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 ⓘ

There are no such residues in this entry.

5.8 Polymer linkage issues

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	376/412 (91%)	0.57	32 (8%) 16 17	28, 54, 97, 118	0

All (32) RSRZ outliers are listed below:

Mol	Chain	Res	Type	RSRZ
1	A	154	TYR	4.7
1	A	170	PHE	4.0
1	A	37	ASP	3.4
1	A	132	TRP	3.0
1	A	138	LYS	2.9
1	A	385	GLN	2.8
1	A	200	ILE	2.8
1	A	155	LEU	2.8
1	A	60	ASN	2.5
1	A	197	PRO	2.5
1	A	145	TYR	2.5
1	A	109	ASP	2.5
1	A	119	ALA	2.5
1	A	177	TRP	2.5
1	A	157	TYR	2.5
1	A	173	TYR	2.4
1	A	161	GLU	2.4
1	A	183	CYS	2.4
1	A	131	THR	2.3
1	A	393	LEU	2.3
1	A	281	ARG	2.2
1	A	261	GLU	2.2
1	A	56	LEU	2.2
1	A	160	ARG	2.2
1	A	117	GLU	2.1
1	A	139	TRP	2.1
1	A	129	HIS	2.1

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Mol	Chain	Res	Type	RSRZ
1	A	158	VAL	2.1
1	A	59	PRO	2.1
1	A	179	VAL	2.1
1	A	140	LYS	2.0
1	A	110	ILE	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](#)

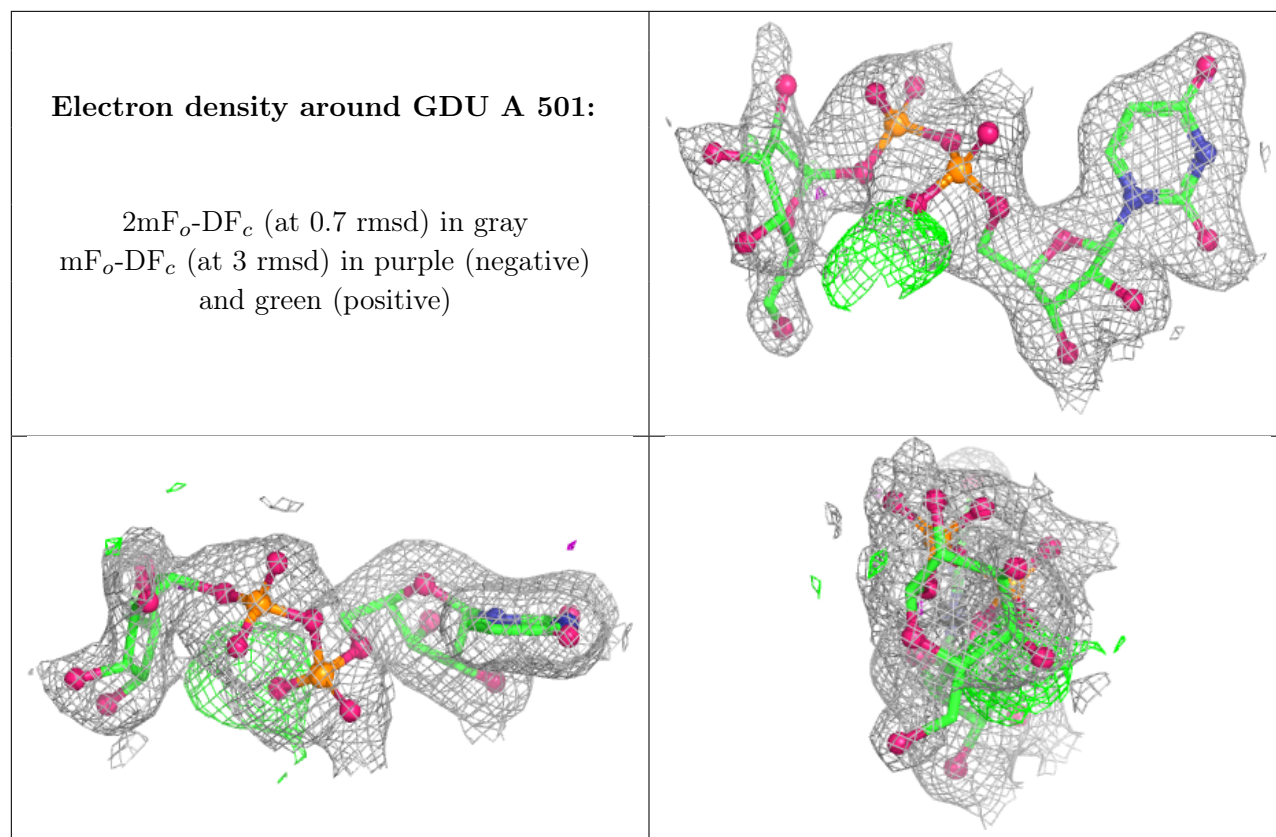
There are no oligosaccharides in this entry.

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($\text{\AA}^2$)	Q<0.9
2	GDU	A	501	36/36	0.93	0.09	26,38,88,89	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.



6.5 Other polymers [i](#)

There are no such residues in this entry.