



# wwPDB X-ray Structure Validation Summary Report ⓘ

Oct 9, 2023 – 10:11 PM EDT

PDB ID : 6X24  
Title : Structural basis of plant blue light photoreceptor  
Authors : Palayam, M.; Ganapathy, J.; Guercio, M.A.; Shabek, N.  
Deposited on : 2020-05-19  
Resolution : 3.25 Å(reported)

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

We welcome your comments at [validation@mail.wwpdb.org](mailto: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>.

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The following versions of software and data (see [references ⓘ](#)) were used in the production of this report:

MolProbity : 4.02b-467  
Mogul : 1.8.5 (274361), CSD as541be (2020)  
Xtriage (Phenix) : 1.13  
EDS : 2.35.1  
buster-report : 1.1.7 (2018)  
Percentile statistics : 20191225.v01 (using entries in the PDB archive December 25th 2019)  
Refmac : 5.8.0158  
CCP4 : 7.0.044 (Gargrove)  
Ideal geometry (proteins) : Engh & Huber (2001)  
Ideal geometry (DNA, RNA) : Parkinson et al. (1996)  
Validation Pipeline (wwPDB-VP) : 2.35.1

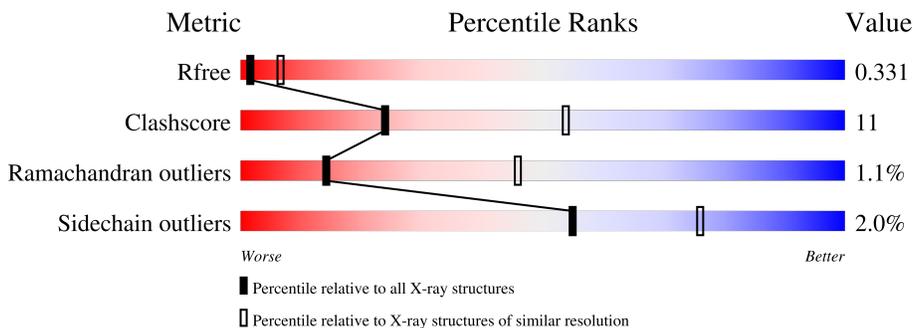
# 1 Overall quality at a glance

The following experimental techniques were used to determine the structure:

*X-RAY DIFFRACTION*

The reported resolution of this entry is 3.25 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))
$R_{free}$	130704	1191 (3.30-3.22)
Clashscore	141614	1251 (3.30-3.22)
Ramachandran outliers	138981	1229 (3.30-3.22)
Sidechain outliers	138945	1228 (3.30-3.22)

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  $\geq 3$ , 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  $\leq 5\%$ .

Mol	Chain	Length	Quality of chain
1	A	498	75% (green), 18% (yellow), 6% (grey)
1	B	498	68% (green), 24% (yellow), 6% (grey)
1	C	498	71% (green), 21% (yellow), 5% (grey)
1	D	498	72% (green), 21% (yellow), 6% (grey)

## 2 Entry composition [i](#)

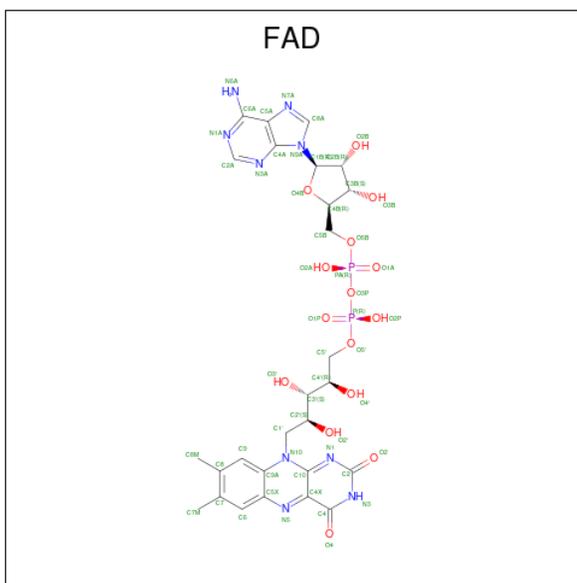
There are 4 unique types of molecules in this entry. The entry contains 15611 atoms, of which 0 are hydrogens and 0 are deuteriums.

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 Cryptochrome-2.

Mol	Chain	Residues	Atoms					ZeroOcc	AltConf	Trace
			Total	C	N	O	S			
1	A	469	Total 3815	C 2470	N 648	O 682	S 15	0	0	0
1	B	469	Total 3815	C 2470	N 648	O 682	S 15	0	0	0
1	C	471	Total 3828	C 2477	N 650	O 686	S 15	0	0	0
1	D	470	Total 3821	C 2473	N 649	O 684	S 15	0	0	0

- Molecule 2 is FLAVIN-ADENINE DINUCLEOTIDE (three-letter code: FAD) (formula: C<sub>27</sub>H<sub>33</sub>N<sub>9</sub>O<sub>15</sub>P<sub>2</sub>) (labeled as "Ligand of Interest" by depositor).



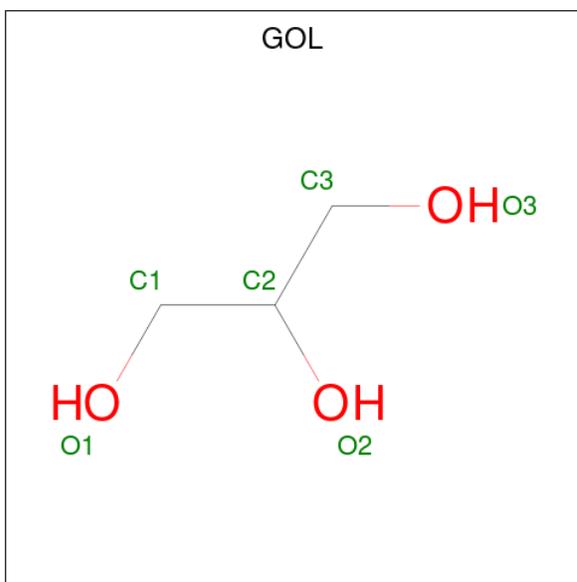
Mol	Chain	Residues	Atoms				ZeroOcc	AltConf	
			Total	C	N	O			P
2	A	1	Total 53	C 27	N 9	O 15	P 2	0	0
2	B	1	Total 53	C 27	N 9	O 15	P 2	0	0

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Mol	Chain	Residues	Atoms					ZeroOcc	AltConf
2	C	1	Total	C	N	O	P	0	0
			53	27	9	15	2		
2	D	1	Total	C	N	O	P	0	0
			53	27	9	15	2		

- Molecule 3 is GLYCEROL (three-letter code: GOL) (formula: C<sub>3</sub>H<sub>8</sub>O<sub>3</sub>).



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

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Mol	Chain	Residues	Atoms	ZeroOcc	AltConf
3	C	1	Total C O 6 3 3	0	0
3	C	1	Total C O 6 3 3	0	0
3	C	1	Total C O 6 3 3	0	0
3	D	1	Total C O 6 3 3	0	0
3	D	1	Total C O 6 3 3	0	0
3	D	1	Total C O 6 3 3	0	0

- Molecule 4 is water.

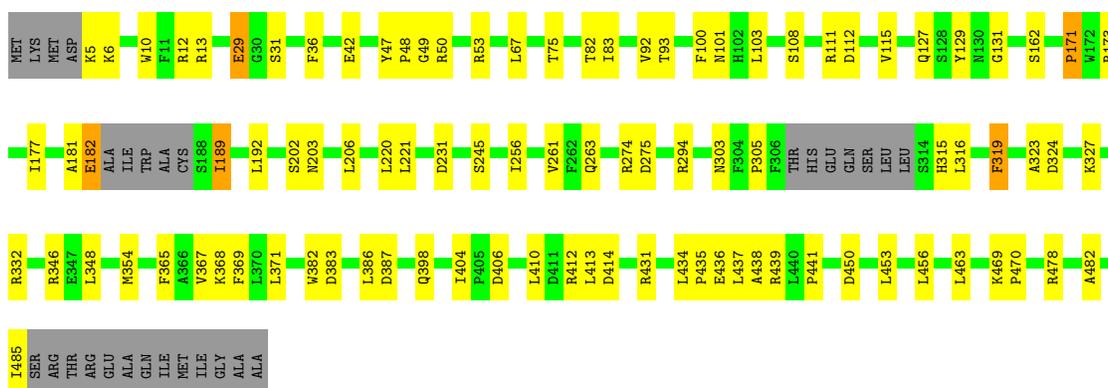
Mol	Chain	Residues	Atoms	ZeroOcc	AltConf
4	A	6	Total O 6 6	0	0
4	B	9	Total O 9 9	0	0
4	C	5	Total O 5 5	0	0
4	D	10	Total O 10 10	0	0

### 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. Residues are color-coded according to the number of geometric quality criteria for which they contain at least one outlier: green = 0, yellow = 1, orange = 2 and red = 3 or more. Stretches of 2 or more consecutive residues without any outlier are shown as a green connector. Residues present in the sample, but not in the model, are shown in grey.

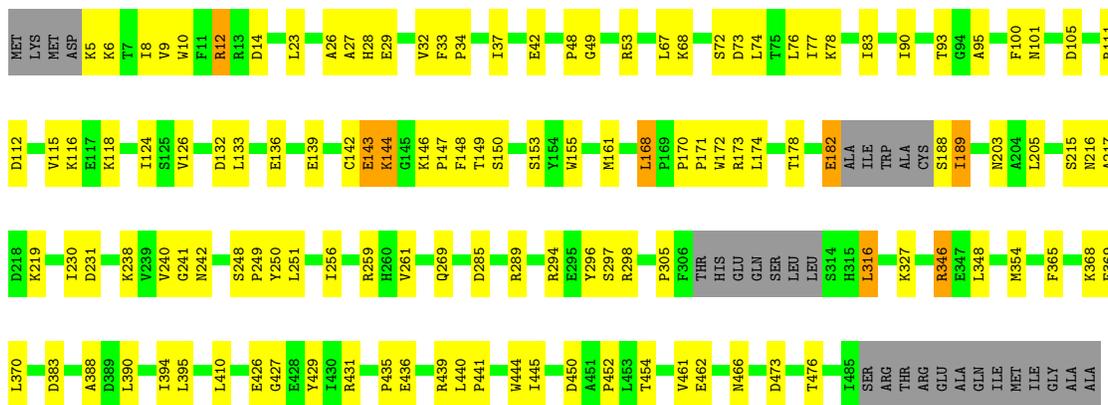
- Molecule 1: Cryptochrome-2

Chain A:  75% 18% • 6%



- Molecule 1: Cryptochrome-2

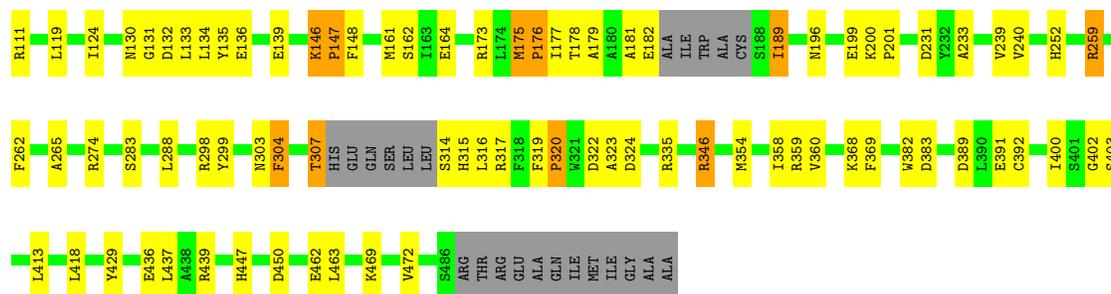
Chain B:  68% 24% • 6%



- Molecule 1: Cryptochrome-2

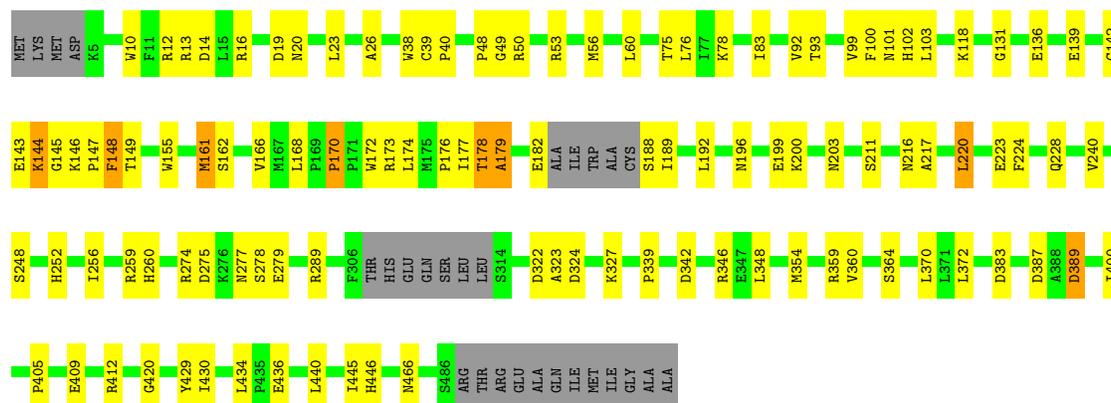
Chain C:  71% 21% • 5%





- Molecule 1: Cryptochrome-2

Chain D: 72% 21% 6%



## 4 Data and refinement statistics i

Property	Value	Source
Space group	P 31	Depositor
Cell constants a, b, c, $\alpha$ , $\beta$ , $\gamma$	208.36Å 208.36Å 81.61Å 90.00° 90.00° 120.00°	Depositor
Resolution (Å)	50.05 – 3.25 50.05 – 3.25	Depositor EDS
% Data completeness (in resolution range)	99.4 (50.05-3.25) 93.3 (50.05-3.25)	Depositor EDS
$R_{merge}$	(Not available)	Depositor
$R_{sym}$	(Not available)	Depositor
$\langle I/\sigma(I) \rangle$ <sup>1</sup>	1.57 (at 3.25Å)	Xtrriage
Refinement program	PHENIX 1.17.1_3660	Depositor
R, $R_{free}$	0.271 , 0.329 0.273 , 0.331	Depositor DCC
$R_{free}$ test set	1992 reflections (3.22%)	wwPDB-VP
Wilson B-factor (Å <sup>2</sup> )	41.9	Xtrriage
Anisotropy	0.676	Xtrriage
Bulk solvent $k_{sol}$ (e/Å <sup>3</sup> ), $B_{sol}$ (Å <sup>2</sup> )	0.33 , 8.9	EDS
L-test for twinning <sup>2</sup>	$\langle  L  \rangle = 0.40$ , $\langle L^2 \rangle = 0.22$	Xtrriage
Estimated twinning fraction	0.307 for -h,-k,l 0.398 for h,-h-k,-l 0.310 for -k,-h,-l	Xtrriage
$F_o, F_c$ correlation	0.85	EDS
Total number of atoms	15611	wwPDB-VP
Average B, all atoms (Å <sup>2</sup> )	53.0	wwPDB-VP

Xtrriage's analysis on translational NCS is as follows: *The largest off-origin peak in the Patterson function is 2.20% of the height of the origin peak. No significant pseudotranslation is detected.*

<sup>1</sup>Intensities estimated from amplitudes.

<sup>2</sup>Theoretical 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 [i](#)

### 5.1 Standard geometry [i](#)

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

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	0.27	0/3928	0.43	0/5337
1	B	0.31	0/3928	0.45	0/5337
1	C	0.26	0/3941	0.42	0/5355
1	D	0.28	0/3934	0.42	0/5345
All	All	0.28	0/15731	0.43	0/21374

There are no bond length outliers.

There are no bond angle outliers.

There are no chirality outliers.

There are no planarity outliers.

### 5.2 Too-close contacts [i](#)

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	3815	0	3752	71	0
1	B	3815	0	3752	109	0
1	C	3828	0	3764	95	0
1	D	3821	0	3757	86	0
2	A	53	0	31	3	0
2	B	53	0	31	2	0
2	C	53	0	31	1	0
2	D	53	0	31	5	0
3	A	24	0	32	1	0

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Mol	Chain	Non-H	H(model)	H(added)	Clashes	Symm-Clashes
3	B	12	0	16	1	0
3	C	36	0	48	0	0
3	D	18	0	24	1	0
4	A	6	0	0	0	0
4	B	9	0	0	0	0
4	C	5	0	0	0	0
4	D	10	0	0	0	0
All	All	15611	0	15269	343	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 11.

The worst 5 of 343 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:142:CYS:HB3	1:D:148:PHE:CE2	1.43	1.52
1:D:142:CYS:HB3	1:D:148:PHE:CZ	1.57	1.36
1:B:240:VAL:CG2	1:B:429:TYR:HB2	1.57	1.32
1:D:142:CYS:CB	1:D:148:PHE:CZ	2.21	1.24
1:D:142:CYS:CB	1:D:148:PHE:CE2	2.24	1.21

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	463/498 (93%)	429 (93%)	30 (6%)	4 (1%)	17 50
1	B	463/498 (93%)	424 (92%)	35 (8%)	4 (1%)	17 50
1	C	465/498 (93%)	419 (90%)	41 (9%)	5 (1%)	14 46
1	D	464/498 (93%)	419 (90%)	38 (8%)	7 (2%)	10 39

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Mol	Chain	Analysed	Favoured	Allowed	Outliers	Percentiles
All	All	1855/1992 (93%)	1691 (91%)	144 (8%)	20 (1%)	14 46

5 of 20 Ramachandran outliers are listed below:

Mol	Chain	Res	Type
1	A	189	ILE
1	D	148	PHE
1	D	178	THR
1	B	305	PRO
1	C	147	PRO

### 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	406/429 (95%)	401 (99%)	5 (1%)	71 83
1	B	406/429 (95%)	395 (97%)	11 (3%)	44 70
1	C	408/429 (95%)	398 (98%)	10 (2%)	47 71
1	D	407/429 (95%)	400 (98%)	7 (2%)	60 78
All	All	1627/1716 (95%)	1594 (98%)	33 (2%)	55 76

5 of 33 residues with a non-rotameric sidechain are listed below:

Mol	Chain	Res	Type
1	D	170	PRO
1	D	174	LEU
1	D	389	ASP
1	B	238	LYS
1	B	231	ASP

Sometimes sidechains can be flipped to improve hydrogen bonding and reduce clashes. 5 of 9 such sidechains are listed below:

Mol	Chain	Res	Type
1	D	45	GLN
1	D	62	HIS
1	A	419	GLN
1	C	62	HIS
1	C	260	HIS

### 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 monosaccharides in this entry.

### 5.6 Ligand geometry [i](#)

19 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	$\# Z  > 2$
3	GOL	C	504	-	5,5,5	0.91	0	5,5,5	1.01	0
3	GOL	A	504	-	5,5,5	0.94	0	5,5,5	0.99	0
3	GOL	C	503	-	5,5,5	0.91	0	5,5,5	1.00	0
3	GOL	C	505	-	5,5,5	0.92	0	5,5,5	0.99	0
3	GOL	A	502	-	5,5,5	0.91	0	5,5,5	1.00	0
3	GOL	D	504	-	5,5,5	0.91	0	5,5,5	1.01	0
3	GOL	A	503	-	5,5,5	0.91	0	5,5,5	1.00	0
3	GOL	A	505	-	5,5,5	0.90	0	5,5,5	1.01	0
3	GOL	B	503	-	5,5,5	0.90	0	5,5,5	1.01	0
3	GOL	C	506	-	5,5,5	0.92	0	5,5,5	1.00	0

Mol	Type	Chain	Res	Link	Bond lengths			Bond angles		
					Counts	RMSZ	# Z  > 2	Counts	RMSZ	# Z  > 2
3	GOL	D	502	-	5,5,5	0.91	0	5,5,5	1.00	0
3	GOL	C	502	-	5,5,5	0.92	0	5,5,5	1.00	0
3	GOL	D	503	-	5,5,5	0.92	0	5,5,5	0.99	0
3	GOL	C	507	-	5,5,5	0.91	0	5,5,5	0.98	0
3	GOL	B	502	-	5,5,5	0.91	0	5,5,5	1.01	0
2	FAD	D	501	-	53,58,58	0.59	0	68,89,89	0.65	1 (1%)
2	FAD	A	501	-	53,58,58	0.59	0	68,89,89	0.66	1 (1%)
2	FAD	B	501	-	53,58,58	0.59	0	68,89,89	0.66	1 (1%)
2	FAD	C	501	-	53,58,58	0.58	0	68,89,89	0.66	2 (2%)

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
3	GOL	C	504	-	-	0/4/4/4	-
3	GOL	A	504	-	-	0/4/4/4	-
3	GOL	C	503	-	-	0/4/4/4	-
3	GOL	C	505	-	-	0/4/4/4	-
3	GOL	A	502	-	-	3/4/4/4	-
3	GOL	D	504	-	-	2/4/4/4	-
3	GOL	A	503	-	-	0/4/4/4	-
3	GOL	A	505	-	-	0/4/4/4	-
3	GOL	B	503	-	-	0/4/4/4	-
3	GOL	C	506	-	-	0/4/4/4	-
3	GOL	D	502	-	-	0/4/4/4	-
3	GOL	C	502	-	-	0/4/4/4	-
3	GOL	D	503	-	-	2/4/4/4	-
3	GOL	C	507	-	-	0/4/4/4	-
3	GOL	B	502	-	-	0/4/4/4	-
2	FAD	D	501	-	-	12/30/50/50	0/6/6/6
2	FAD	A	501	-	-	12/30/50/50	0/6/6/6
2	FAD	B	501	-	-	14/30/50/50	0/6/6/6
2	FAD	C	501	-	-	13/30/50/50	0/6/6/6

There are no bond length outliers.

All (5) bond angle outliers are listed below:

Mol	Chain	Res	Type	Atoms	Z	Observed(°)	Ideal(°)
2	C	501	FAD	C5A-C6A-N6A	2.32	123.87	120.35
2	B	501	FAD	C5A-C6A-N6A	2.32	123.87	120.35
2	A	501	FAD	C5A-C6A-N6A	2.31	123.87	120.35
2	D	501	FAD	C5A-C6A-N6A	2.27	123.81	120.35
2	C	501	FAD	C4-N3-C2	-2.01	121.92	125.64

There are no chirality outliers.

5 of 58 torsion outliers are listed below:

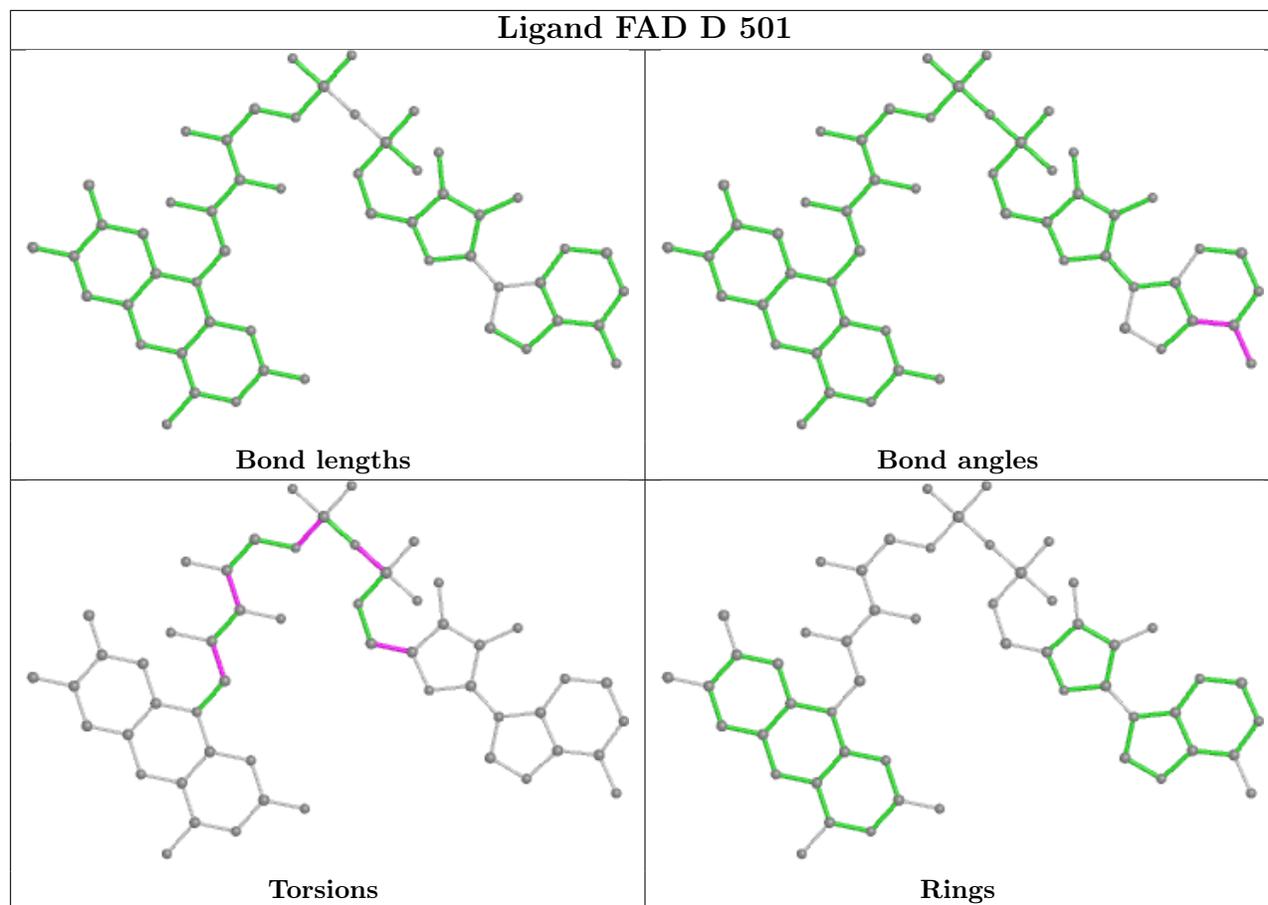
Mol	Chain	Res	Type	Atoms
2	A	501	FAD	C5B-O5B-PA-O1A
2	A	501	FAD	N10-C1'-C2'-O2'
2	A	501	FAD	N10-C1'-C2'-C3'
2	B	501	FAD	N10-C1'-C2'-O2'
2	B	501	FAD	N10-C1'-C2'-C3'

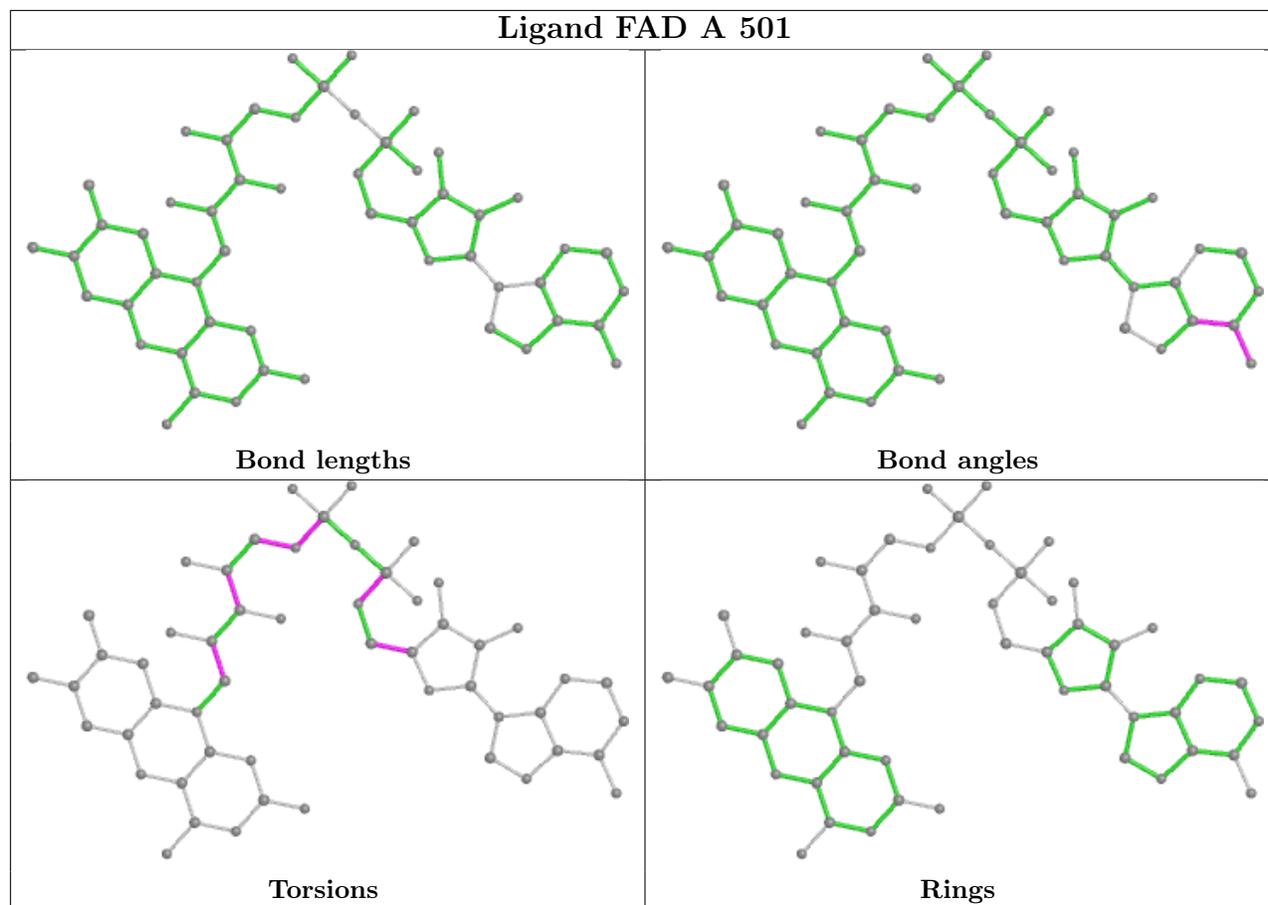
There are no ring outliers.

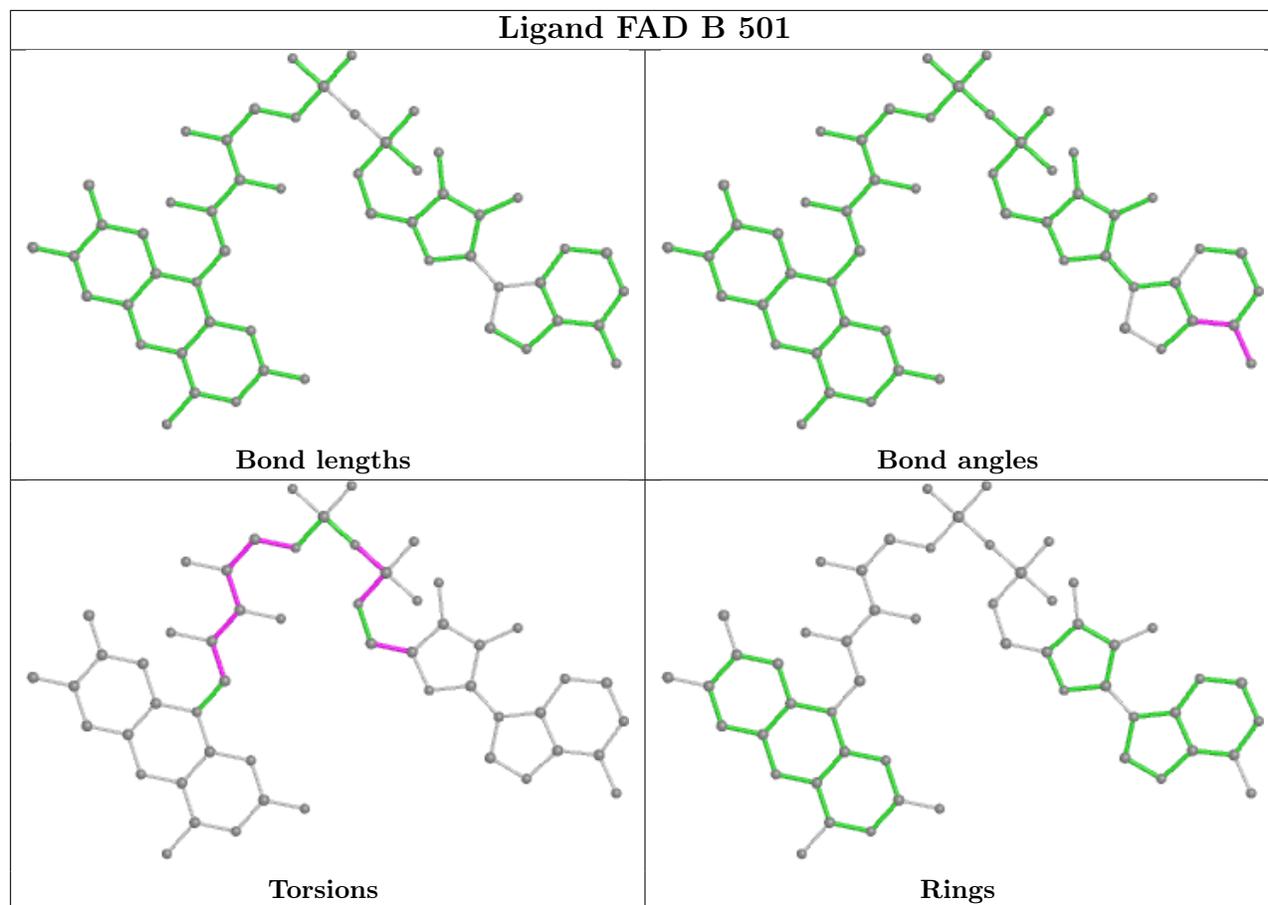
7 monomers are involved in 14 short contacts:

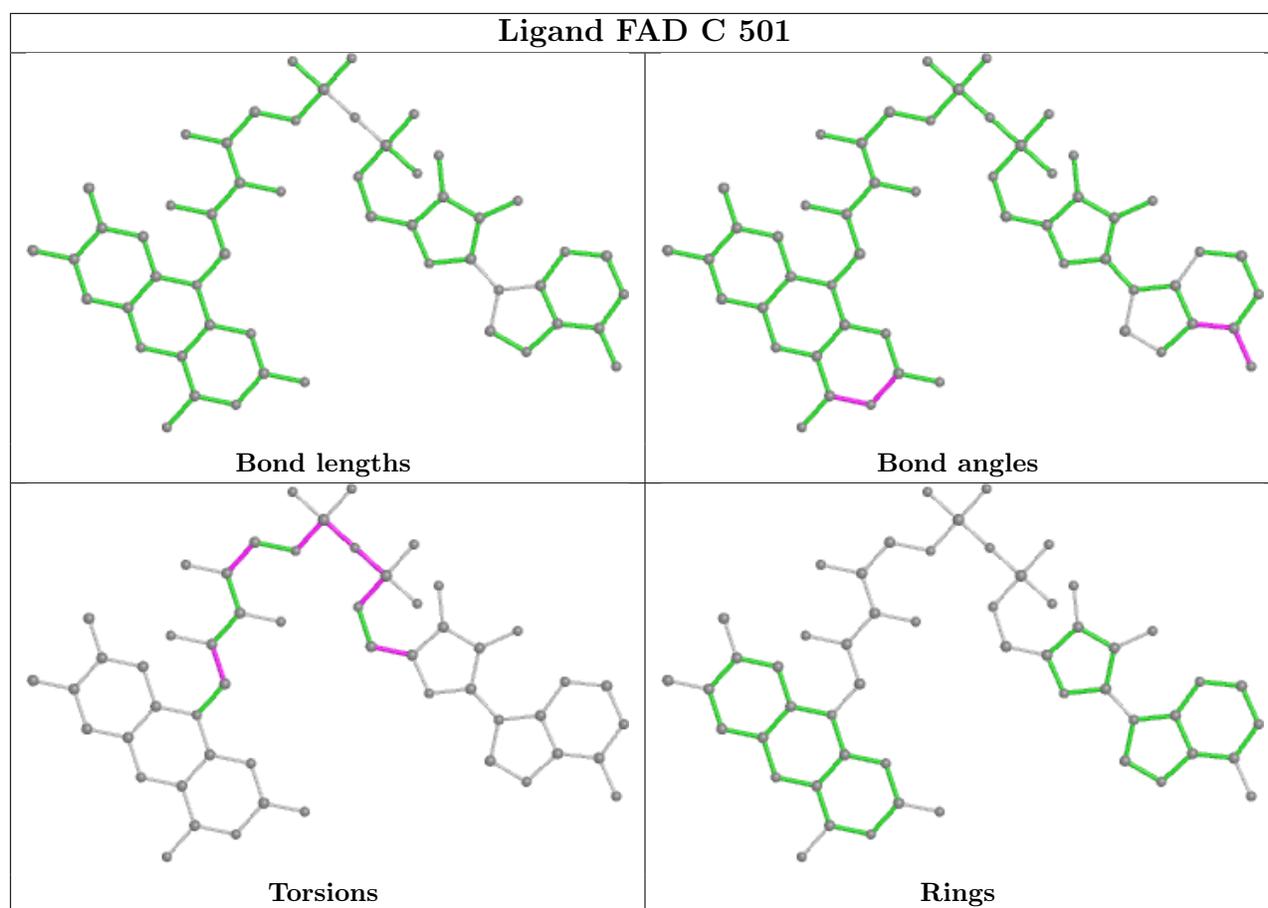
Mol	Chain	Res	Type	Clashes	Symm-Clashes
3	A	504	GOL	1	0
3	D	504	GOL	1	0
3	B	502	GOL	1	0
2	D	501	FAD	5	0
2	A	501	FAD	3	0
2	B	501	FAD	2	0
2	C	501	FAD	1	0

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](#)

Unable to reproduce the depositors R factor - this section is therefore empty.

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

Unable to reproduce the depositors R factor - this section is therefore empty.

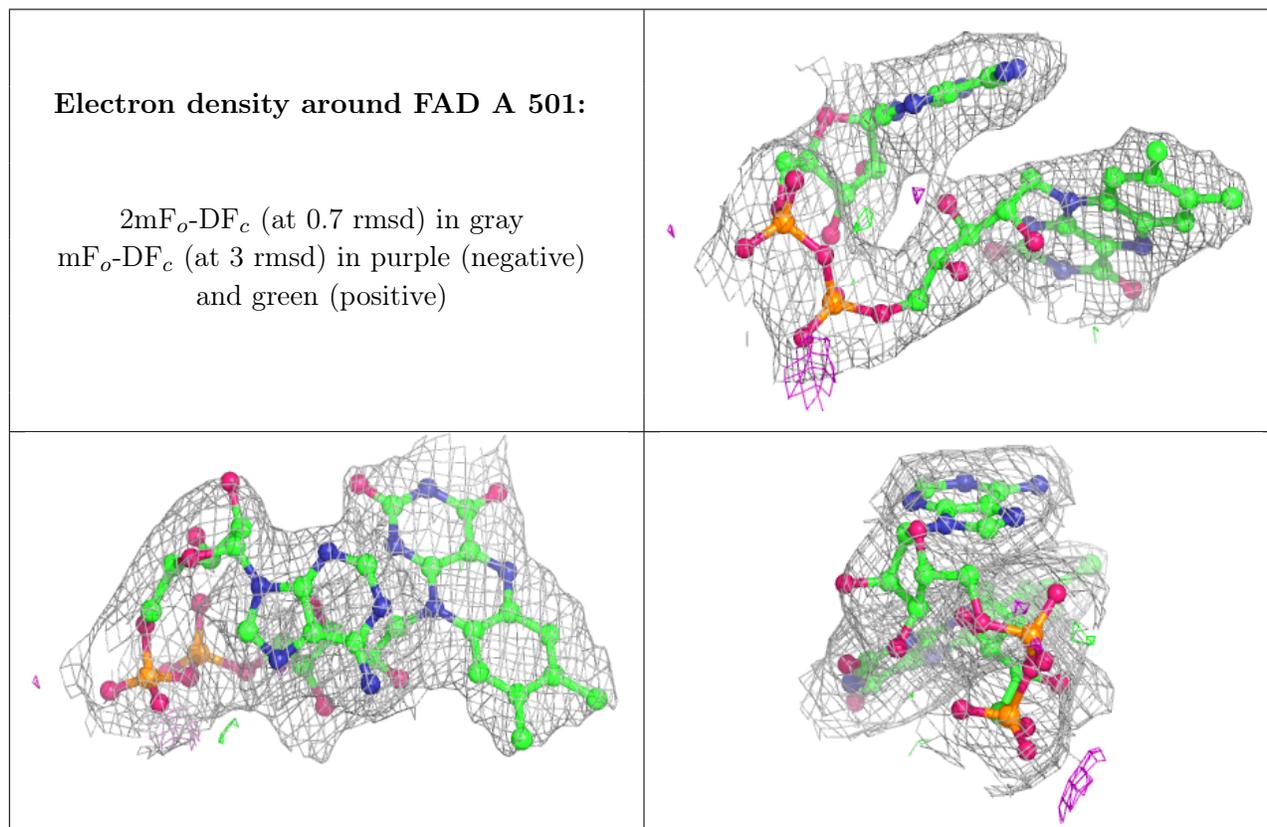
### 6.3 Carbohydrates [i](#)

Unable to reproduce the depositors R factor - this section is therefore empty.

### 6.4 Ligands [i](#)

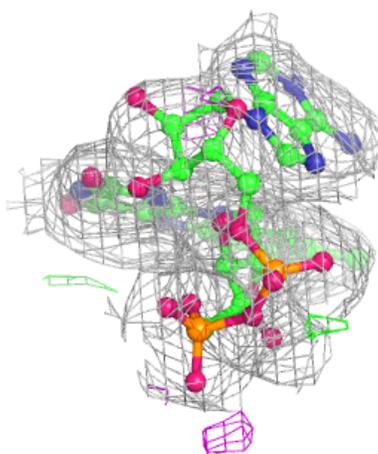
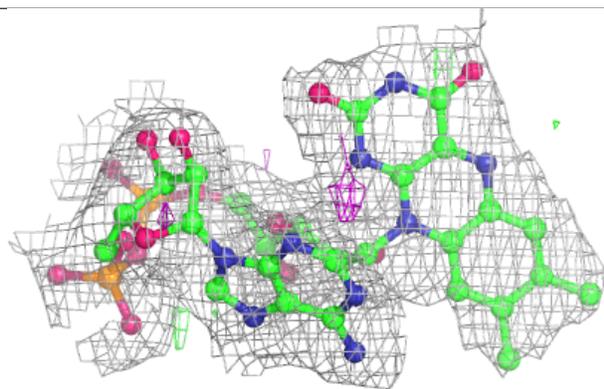
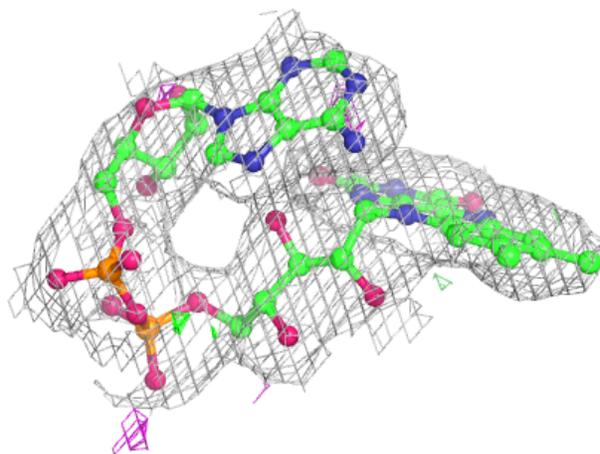
Unable to reproduce the depositors R factor - this section is therefore empty.

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.



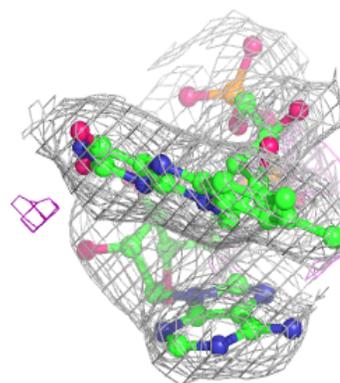
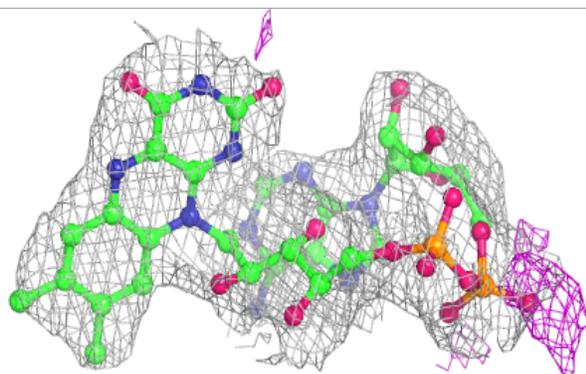
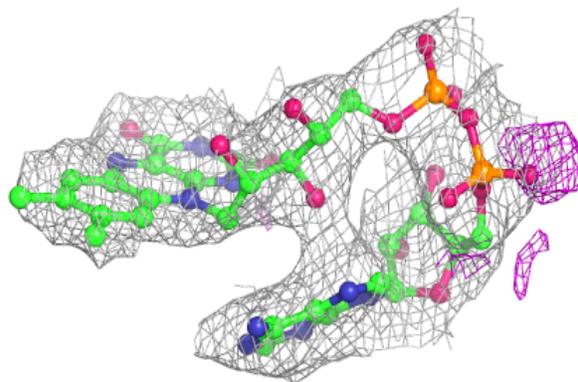
**Electron density around FAD B 501:**

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

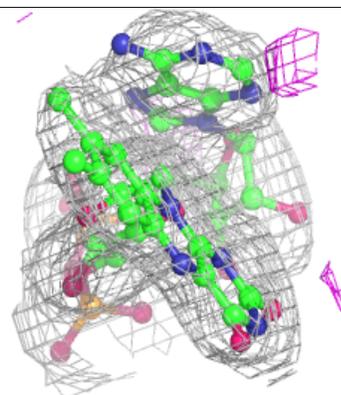
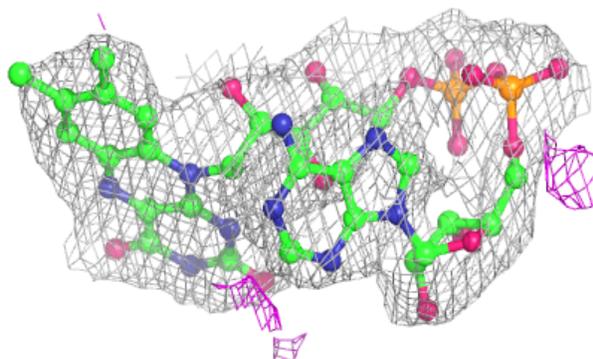
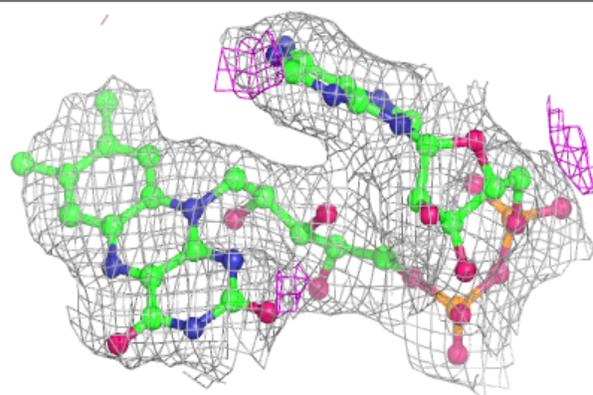


**Electron density around FAD C 501:**

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

**Electron density around FAD D 501:**

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



## 6.5 Other polymers [i](#)

Unable to reproduce the depositors R factor - this section is therefore empty.