



Full wwPDB X-ray Structure Validation Report ⓘ

May 16, 2020 – 02:45 pm BST

PDB ID : 3K88
Title : Crystal structure of NADH:FAD oxidoreductase (TftC) - FAD, NADH complex
Authors : Kang, C.; Webb, B.N.
Deposited on : 2009-10-13
Resolution : 2.00 Å(reported)

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

We welcome your comments at validation@mail.wwpdb.org

A user guide is available at

<https://www.wwpdb.org/validation/2017/XrayValidationReportHelp>

with specific help available everywhere you see the ⓘ symbol.

The 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	:	2.11
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)	:	2.11

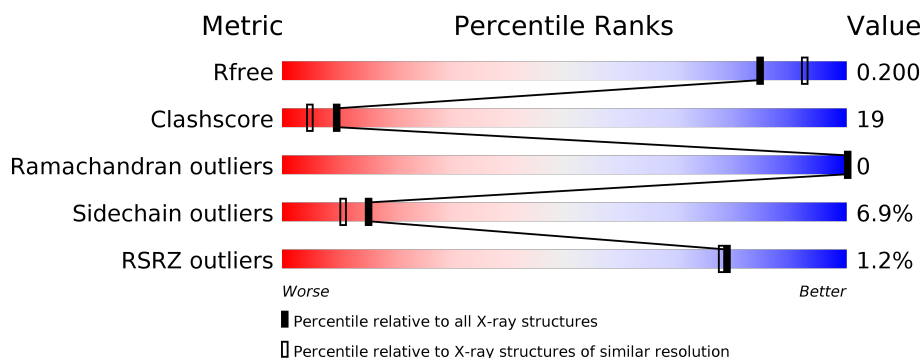
1 Overall quality at a glance

The following experimental techniques were used to determine the structure:

X-RAY DIFFRACTION

The reported resolution of this entry is 2.00 Å.

Percentile scores (ranging between 0-100) for global validation metrics of the entry are shown in the following graphic. The table shows the number of entries on which the scores are based.



Metric	Whole archive (#Entries)	Similar resolution (#Entries, resolution range(Å))
R_{free}	130704	8085 (2.00-2.00)
Clashscore	141614	9178 (2.00-2.00)
Ramachandran outliers	138981	9054 (2.00-2.00)
Sidechain outliers	138945	9053 (2.00-2.00)
RSRZ outliers	127900	7900 (2.00-2.00)

The table below summarises the geometric issues observed across the polymeric chains and their fit to the electron density. The red, orange, yellow and green segments on 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	185	<div> <div style="width: 100%; height: 10px; background: linear-gradient(to right, red, orange, yellow, green, grey);"></div> <div style="display: flex; justify-content: space-between; margin-top: 5px;"> 0% 68% 18% • 11% </div> </div>
1	B	185	<div> <div style="width: 100%; height: 10px; background: linear-gradient(to right, red, orange, yellow, green, grey);"></div> <div style="display: flex; justify-content: space-between; margin-top: 5px;"> 2% 76% 9% • • 11% </div> </div>

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
2	FAD	A	1500	X	-	-	-
2	FAD	B	500	X	-	-	-
3	NAD	A	1501	X	-	-	-
3	NAD	B	501	X	-	-	-

2 Entry composition

There are 4 unique types of molecules in this entry. The entry contains 2897 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.

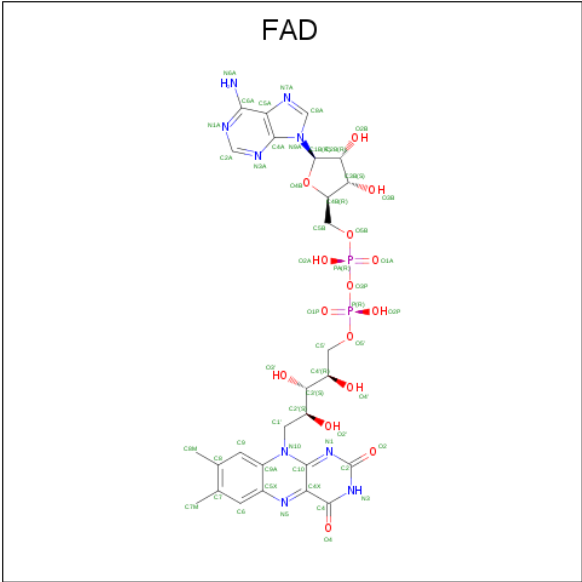
- Molecule 1 is a protein called Chlorophenol-4-monooxygenase component 1.

Mol	Chain	Residues	Atoms					ZeroOcc	AltConf	Trace
1	A	164	Total	C	N	O	S	0	0	0
			1223	771	213	231	8			
1	B	164	Total	C	N	O	S	0	0	0
			1223	771	213	231	8			

There are 12 discrepancies between the modelled and reference sequences:

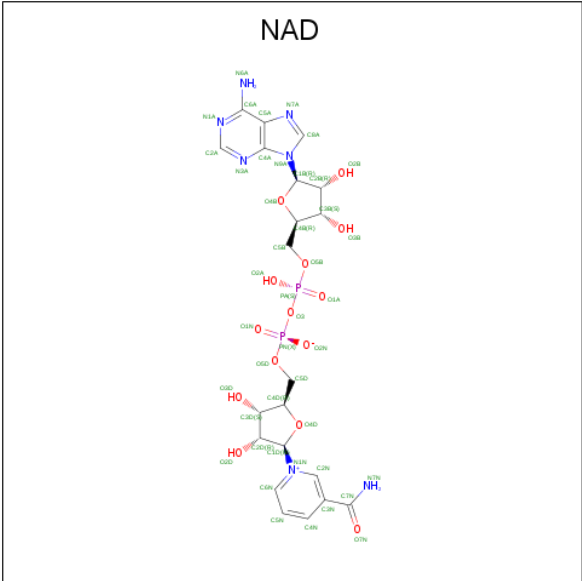
Chain	Residue	Modelled	Actual	Comment	Reference
A	1180	HIS	-	EXPRESSION TAG	UNP O87008
A	1181	HIS	-	EXPRESSION TAG	UNP O87008
A	1182	HIS	-	EXPRESSION TAG	UNP O87008
A	1183	HIS	-	EXPRESSION TAG	UNP O87008
A	1184	HIS	-	EXPRESSION TAG	UNP O87008
A	1185	HIS	-	EXPRESSION TAG	UNP O87008
B	180	HIS	-	EXPRESSION TAG	UNP O87008
B	181	HIS	-	EXPRESSION TAG	UNP O87008
B	182	HIS	-	EXPRESSION TAG	UNP O87008
B	183	HIS	-	EXPRESSION TAG	UNP O87008
B	184	HIS	-	EXPRESSION TAG	UNP O87008
B	185	HIS	-	EXPRESSION TAG	UNP O87008

- Molecule 2 is FLAVIN-ADENINE DINUCLEOTIDE (three-letter code: FAD) (formula: $C_{27}H_{33}N_9O_{15}P_2$).



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

- Molecule 3 is NICOTINAMIDE-ADENINE-DINUCLEOTIDE (three-letter code: NAD) (formula: C₂₁H₂₇N₇O₁₄P₂).



Mol	Chain	Residues	Atoms					ZeroOcc	AltConf
3	A	1	Total	C	N	O	P	0	0
			44	21	7	14	2		

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Mol	Chain	Residues	Atoms					ZeroOcc	AltConf
3	B	1	Total	C	N	O	P	0	0
			44	21	7	14	2		

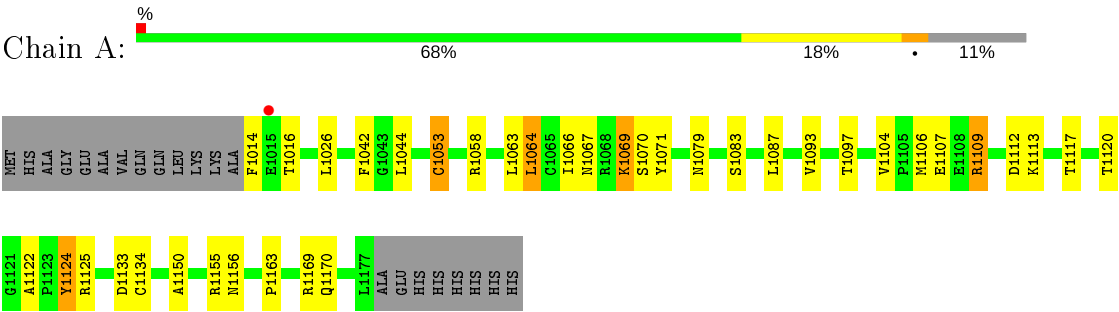
- Molecule 4 is water.

Mol	Chain	Residues	Atoms		ZeroOcc	AltConf
4	A	138	Total	O	0	0
			138	138		
4	B	119	Total	O	0	0
			119	119		

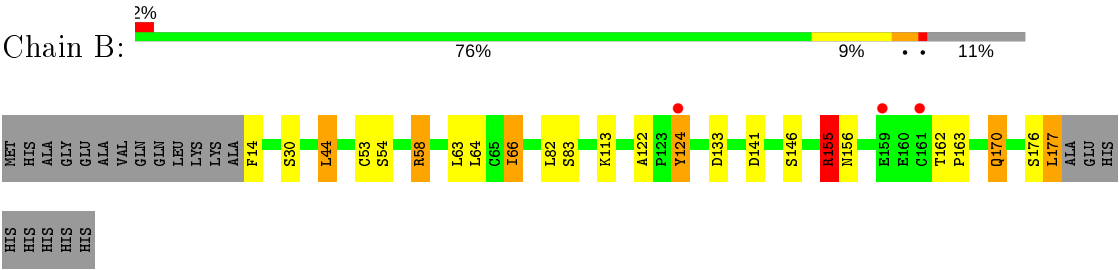
3 Residue-property plots

These plots are drawn for all protein, RNA and DNA 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: Chlorophenol-4-monooxygenase component 1



- Molecule 1: Chlorophenol-4-monooxygenase component 1



4 Data and refinement statistics

Property	Value	Source
Space group	H 3	Depositor
Cell constants a, b, c, α , β , γ	113.09Å 113.09Å 101.68Å 90.00° 90.00° 120.00°	Depositor
Resolution (Å)	19.24 – 2.00 35.27 – 1.58	Depositor EDS
% Data completeness (in resolution range)	83.6 (19.24-2.00) 54.5 (35.27-1.58)	Depositor EDS
R_{merge}	(Not available)	Depositor
R_{sym}	(Not available)	Depositor
$\langle I/\sigma(I) \rangle$ ¹	1.62 (at 1.58Å)	Xtriage
Refinement program	PHENIX	Depositor
R, R_{free}	0.164 , 0.203 0.161 , 0.200	Depositor DCC
R_{free} test set	1988 reflections (4.88%)	wwPDB-VP
Wilson B-factor (Å ²)	21.6	Xtriage
Anisotropy	0.123	Xtriage
Bulk solvent k_{sol} (e/Å ³), B_{sol} (Å ²)	0.35 , 44.3	EDS
L-test for twinning ²	$\langle L \rangle = 0.51$, $\langle L^2 \rangle = 0.35$	Xtriage
Estimated twinning fraction	0.015 for h,-h-k,-l	Xtriage
F_o, F_c correlation	0.97	EDS
Total number of atoms	2897	wwPDB-VP
Average B, all atoms (Å ²)	31.0	wwPDB-VP

Xtriage's analysis on translational NCS is as follows: *The largest off-origin peak in the Patterson function is 6.13% 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 [i](#)

5.1 Standard geometry [i](#)

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

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	1.01	2/1248 (0.2%)	1.09	3/1702 (0.2%)
1	B	1.03	1/1248 (0.1%)	0.96	4/1702 (0.2%)
All	All	1.02	3/2496 (0.1%)	1.03	7/3404 (0.2%)

All (3) bond length outliers are listed below:

Mol	Chain	Res	Type	Atoms	Z	Observed(Å)	Ideal(Å)
1	B	124	TYR	CG-CD1	-5.65	1.31	1.39
1	A	1053	CYS	CB-SG	-5.37	1.73	1.81
1	A	1124	TYR	CD2-CE2	5.11	1.47	1.39

All (7) bond angle outliers are listed below:

Mol	Chain	Res	Type	Atoms	Z	Observed(°)	Ideal(°)
1	A	1109	ARG	NE-CZ-NH2	17.72	129.16	120.30
1	A	1109	ARG	NE-CZ-NH1	-15.12	112.74	120.30
1	B	155	ARG	NE-CZ-NH2	-6.91	116.84	120.30
1	A	1109	ARG	CD-NE-CZ	6.03	132.04	123.60
1	B	155	ARG	NE-CZ-NH1	5.13	122.86	120.30
1	B	44	LEU	CA-CB-CG	5.07	126.97	115.30
1	B	124	TYR	CB-CG-CD2	-5.01	117.99	121.00

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	1223	0	1209	47	0
1	B	1223	0	1210	38	0
2	A	53	0	28	14	0
2	B	53	0	29	2	0
3	A	44	0	22	10	0
3	B	44	0	22	1	0
4	A	138	0	0	7	0
4	B	119	0	0	6	1
All	All	2897	0	2520	100	1

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 19.

All (100) 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)
2:B:500:FAD:C4B	2:B:500:FAD:C3B	1.81	1.53
2:A:1500:FAD:C4B	2:A:1500:FAD:C3B	1.81	1.50
1:A:1124:TYR:OH	1:A:1133:ASP:OD2	1.53	1.22
1:B:124:TYR:OH	1:B:133:ASP:OD1	1.58	1.17
1:B:124:TYR:CE1	1:B:133:ASP:HA	1.88	1.08
1:A:1083:SER:HB3	1:A:1124:TYR:CE1	1.91	1.05
1:A:1124:TYR:CZ	1:A:1133:ASP:CG	2.31	1.04
1:B:124:TYR:HE1	1:B:133:ASP:HA	1.21	1.01
2:A:1500:FAD:H61A	3:A:1501:NAD:H62A	1.01	0.99
1:A:1069:LYS:HD2	1:A:1069:LYS:C	1.82	0.99
3:A:1501:NAD:H8A	1:B:54:SER:OG	1.64	0.97
1:B:122:ALA:O	1:B:124:TYR:CE2	2.18	0.97
1:B:124:TYR:CZ	1:B:133:ASP:OD1	2.19	0.96
1:A:1124:TYR:CE1	1:A:1133:ASP:HA	2.05	0.92
1:B:83:SER:HB3	1:B:124:TYR:CE1	2.04	0.92
1:A:1067:ASN:HB3	1:A:1069:LYS:HE3	1.53	0.89
1:B:124:TYR:CE1	1:B:133:ASP:CA	2.57	0.88
1:A:1124:TYR:OH	1:A:1133:ASP:CG	2.13	0.87
1:A:1069:LYS:HD2	1:A:1070:SER:N	1.93	0.82
1:A:1122:ALA:HB3	1:A:1124:TYR:CZ	2.15	0.82
1:B:122:ALA:HB3	1:B:124:TYR:OH	1.81	0.81
1:A:1163:PRO:HG2	1:B:30:SER:OG	1.83	0.78
1:B:122:ALA:O	1:B:124:TYR:HE2	1.67	0.78

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Atom-1	Atom-2	Interatomic distance (Å)	Clash overlap (Å)
1:B:124:TYR:HE1	1:B:133:ASP:CA	1.93	0.77
1:A:1122:ALA:O	1:A:1124:TYR:CE2	2.38	0.77
1:A:1124:TYR:HE1	1:A:1133:ASP:HA	1.45	0.77
1:A:1083:SER:CB	1:A:1124:TYR:CE1	2.68	0.76
1:B:122:ALA:O	1:B:124:TYR:CD2	2.38	0.76
1:A:1122:ALA:HB3	1:A:1124:TYR:OH	1.86	0.76
1:B:83:SER:CB	1:B:124:TYR:CE1	2.68	0.75
3:A:1501:NAD:H6N	4:A:215:HOH:O	1.87	0.75
1:B:124:TYR:CZ	1:B:133:ASP:CG	2.62	0.73
2:A:1500:FAD:N6A	3:A:1501:NAD:N6A	2.35	0.72
1:A:1083:SER:HB3	1:A:1124:TYR:CD1	2.25	0.71
1:A:1069:LYS:HD3	2:A:1500:FAD:H51A	1.71	0.71
3:A:1501:NAD:PA	4:A:191:HOH:O	2.49	0.70
1:B:122:ALA:HB3	1:B:124:TYR:CZ	2.27	0.69
1:A:1042:PHE:H	1:A:1079:ASN:HD21	1.38	0.69
1:B:83:SER:HB3	1:B:124:TYR:CZ	2.26	0.68
2:A:1500:FAD:H4B	2:A:1500:FAD:O1A	1.93	0.67
1:A:1169:ARG:NE	3:A:1501:NAD:O2A	2.29	0.66
1:B:122:ALA:HB3	1:B:124:TYR:CE2	2.31	0.65
1:A:1104:VAL:O	1:A:1109:ARG:HD2	1.96	0.65
1:B:14:PHE:N	4:B:298:HOH:O	2.28	0.65
1:A:1053:CYS:HB3	4:B:248:HOH:O	1.95	0.65
1:A:1124:TYR:CE1	1:A:1133:ASP:CA	2.78	0.65
1:A:1069:LYS:CD	1:A:1069:LYS:C	2.64	0.64
2:A:1500:FAD:H8A	4:A:143:HOH:O	1.98	0.63
1:A:1083:SER:CB	1:A:1124:TYR:CD1	2.82	0.62
1:B:124:TYR:CE1	1:B:133:ASP:CB	2.83	0.62
1:B:170:GLN:HB2	4:B:294:HOH:O	1.99	0.61
1:B:155:ARG:HD2	1:B:156:ASN:O	2.01	0.60
1:B:64:LEU:HD12	1:B:66:ILE:HG23	1.83	0.60
1:A:1124:TYR:CZ	1:A:1133:ASP:OD1	2.57	0.58
1:A:1124:TYR:CE2	1:A:1133:ASP:OD1	2.58	0.57
1:A:1067:ASN:CB	1:A:1069:LYS:HE3	2.31	0.57
1:B:53:CYS:HB3	4:B:248:HOH:O	2.05	0.56
2:B:500:FAD:C3B	2:B:500:FAD:C5B	2.79	0.56
3:B:501:NAD:H8A	3:B:501:NAD:O5B	2.06	0.56
2:A:1500:FAD:C5B	2:A:1500:FAD:C3B	2.79	0.56
1:B:124:TYR:CZ	1:B:133:ASP:HA	2.40	0.54
1:A:1093:VAL:HG12	4:A:60:HOH:O	2.07	0.54
1:A:1064:LEU:HD12	1:A:1066:ILE:HG23	1.90	0.53
1:B:82:LEU:HD12	1:B:82:LEU:C	2.29	0.53

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Atom-1	Atom-2	Interatomic distance (Å)	Clash overlap (Å)
1:B:176:SER:O	1:B:177:LEU:HB2	2.08	0.53
1:A:1124:TYR:CE1	1:A:1133:ASP:CB	2.93	0.52
1:B:124:TYR:CD2	1:B:124:TYR:N	2.79	0.50
1:A:1026:LEU:HD13	3:A:1501:NAD:H1B	1.93	0.50
1:A:1097:THR:HG22	1:A:1109:ARG:HG2	1.94	0.50
3:A:1501:NAD:H8A	1:B:54:SER:CB	2.41	0.49
1:A:1067:ASN:HD21	2:A:1500:FAD:C4A	2.25	0.48
2:A:1500:FAD:C4B	2:A:1500:FAD:O3B	2.55	0.48
1:A:1069:LYS:HD3	2:A:1500:FAD:C5B	2.41	0.47
1:A:1014:PHE:N	4:A:178:HOH:O	2.48	0.47
1:A:1063:LEU:C	1:A:1063:LEU:HD12	2.34	0.47
1:A:1053:CYS:SG	4:B:248:HOH:O	2.61	0.47
1:A:1124:TYR:CZ	1:A:1133:ASP:CB	2.97	0.46
1:B:63:LEU:HD12	1:B:63:LEU:C	2.35	0.46
1:A:1083:SER:HB2	1:A:1124:TYR:CD1	2.51	0.46
1:A:1134:CYS:HB3	1:A:1150:ALA:HB1	1.98	0.46
3:A:1501:NAD:N3A	3:A:1501:NAD:O4B	2.49	0.45
1:B:122:ALA:C	1:B:124:TYR:CE2	2.88	0.45
1:A:1067:ASN:HD21	2:A:1500:FAD:C5A	2.29	0.45
1:A:1122:ALA:O	1:A:1124:TYR:CD2	2.70	0.45
1:B:155:ARG:CD	1:B:156:ASN:O	2.65	0.45
1:B:162:THR:HA	1:B:163:PRO:HD3	1.82	0.44
1:B:53:CYS:CB	4:B:248:HOH:O	2.63	0.43
3:A:1501:NAD:PA	4:A:128:HOH:O	2.75	0.43
1:A:1120:THR:OG1	1:A:1124:TYR:OH	2.34	0.43
1:A:1112:ASP:OD1	1:A:1125:ARG:NH2	2.42	0.43
1:A:1106:MET:HA	1:A:1109:ARG:HD3	2.00	0.42
2:A:1500:FAD:H4'	4:A:59:HOH:O	2.19	0.42
1:A:1042:PHE:H	1:A:1079:ASN:ND2	2.12	0.42
1:B:141:ASP:OD2	1:B:146:SER:OG	2.30	0.42
1:A:1067:ASN:ND2	2:A:1500:FAD:C5A	2.83	0.41
1:B:83:SER:HB2	1:B:124:TYR:CE1	2.52	0.41
1:A:1044:LEU:HD23	1:A:1107:GLU:HG3	2.02	0.41
2:A:1500:FAD:C5B	2:A:1500:FAD:O3B	2.69	0.41
1:B:176:SER:O	1:B:177:LEU:CB	2.68	0.41
1:B:58:ARG:C	1:B:58:ARG:HD3	2.41	0.41

All (1) symmetry-related close contacts are listed below. The label for Atom-2 includes the symmetry operator and encoded unit-cell translations to be applied.

Atom-1	Atom-2	Interatomic distance (Å)	Clash overlap (Å)
4:B:228:HOH:O	4:B:236:HOH:O[5_655]	2.11	0.09

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	162/185 (88%)	160 (99%)	2 (1%)	0	100	100
1	B	162/185 (88%)	158 (98%)	4 (2%)	0	100	100
All	All	324/370 (88%)	318 (98%)	6 (2%)	0	100	100

There are no Ramachandran outliers to report.

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	131/147 (89%)	120 (92%)	11 (8%)	11	7
1	B	131/147 (89%)	124 (95%)	7 (5%)	22	18
All	All	262/294 (89%)	244 (93%)	18 (7%)	15	11

All (18) residues with a non-rotameric sidechain are listed below:

Mol	Chain	Res	Type
1	A	1016	THR
1	A	1058	ARG
1	A	1064	LEU

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Mol	Chain	Res	Type
1	A	1069	LYS
1	A	1071	TYR
1	A	1087	LEU
1	A	1113	LYS
1	A	1117	THR
1	A	1155	ARG
1	A	1156	ASN
1	A	1170	GLN
1	B	44	LEU
1	B	58	ARG
1	B	66	ILE
1	B	113	LYS
1	B	155	ARG
1	B	170	GLN
1	B	177	LEU

Some sidechains can be flipped to improve hydrogen bonding and reduce clashes. All (5) such sidechains are listed below:

Mol	Chain	Res	Type
1	A	1079	ASN
1	A	1156	ASN
1	B	39	ASN
1	B	116	GLN
1	B	167	HIS

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 ⓘ

There are no carbohydrates in this entry.

5.6 Ligand geometry

4 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	NAD	B	501	-	42,48,48	2.68	15 (35%)	50,73,73	3.14	20 (40%)
3	NAD	A	1501	-	42,48,48	2.89	19 (45%)	50,73,73	2.88	20 (40%)
2	FAD	B	500	-	51,58,58	4.97	30 (58%)	60,89,89	4.40	23 (38%)
2	FAD	A	1500	-	51,58,58	5.12	29 (56%)	60,89,89	4.10	25 (41%)

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	NAD	B	501	-	4/4/11/11	5/26/62/62	0/5/5/5
3	NAD	A	1501	-	4/4/11/11	11/26/62/62	0/5/5/5
2	FAD	B	500	-	2/2/9/9	3/30/50/50	0/6/6/6
2	FAD	A	1500	-	2/2/9/9	13/30/50/50	0/6/6/6

All (93) bond length outliers are listed below:

Mol	Chain	Res	Type	Atoms	Z	Observed(Å)	Ideal(Å)
2	A	1500	FAD	C2B-C1B	-17.84	1.26	1.53
2	B	500	FAD	C2B-C1B	-17.62	1.27	1.53
2	B	500	FAD	O4B-C1B	-14.78	1.20	1.41
2	A	1500	FAD	O4B-C1B	-14.61	1.20	1.41
2	A	1500	FAD	C3B-C4B	11.27	1.81	1.53
2	B	500	FAD	C3B-C4B	10.95	1.81	1.53
2	A	1500	FAD	O2'-C2'	-9.52	1.23	1.43
2	B	500	FAD	O2'-C2'	-9.42	1.23	1.43
3	A	1501	NAD	C7N-N7N	8.77	1.49	1.33
2	A	1500	FAD	C8A-N7A	8.64	1.50	1.34

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Mol	Chain	Res	Type	Atoms	Z	Observed(Å)	Ideal(Å)
2	B	500	FAD	C10-N1	8.14	1.43	1.33
2	B	500	FAD	C8A-N7A	8.08	1.49	1.34
2	B	500	FAD	C2A-N3A	7.89	1.44	1.32
2	A	1500	FAD	C2A-N3A	7.60	1.44	1.32
2	A	1500	FAD	C10-N1	6.69	1.41	1.33
3	A	1501	NAD	C8A-N7A	6.46	1.46	1.34
2	B	500	FAD	C4X-N5	6.45	1.42	1.33
2	A	1500	FAD	C4'-C3'	6.39	1.65	1.53
2	A	1500	FAD	O4'-C4'	6.18	1.56	1.43
3	B	501	NAD	C7N-N7N	5.99	1.44	1.33
3	A	1501	NAD	C6N-N1N	5.87	1.49	1.35
3	B	501	NAD	C2A-N3A	5.84	1.41	1.32
2	A	1500	FAD	P-O1P	5.80	1.71	1.50
2	A	1500	FAD	O4-C4	5.67	1.38	1.24
3	B	501	NAD	C6N-N1N	5.57	1.49	1.35
2	A	1500	FAD	C4X-N5	5.51	1.41	1.33
3	B	501	NAD	C2D-C1D	-5.50	1.45	1.53
2	A	1500	FAD	PA-O1A	5.23	1.69	1.50
3	A	1501	NAD	C2A-N3A	5.09	1.40	1.32
2	B	500	FAD	O4-C4	5.06	1.37	1.24
2	B	500	FAD	C6-C5X	4.96	1.49	1.41
2	A	1500	FAD	C4-N3	4.96	1.41	1.33
3	A	1501	NAD	PN-O1N	4.77	1.67	1.50
3	A	1501	NAD	PA-O1A	4.76	1.67	1.50
2	B	500	FAD	C6A-N6A	4.41	1.50	1.34
2	B	500	FAD	C5'-C4'	4.37	1.58	1.51
2	A	1500	FAD	C9-C8	4.34	1.48	1.37
2	B	500	FAD	C4-N3	4.33	1.40	1.33
3	B	501	NAD	O4D-C4D	-4.28	1.35	1.45
3	B	501	NAD	C8A-N7A	4.27	1.42	1.34
3	B	501	NAD	C4N-C3N	4.26	1.46	1.39
2	B	500	FAD	C9-C8	4.15	1.48	1.37
3	B	501	NAD	PA-O1A	4.13	1.65	1.50
2	A	1500	FAD	C6-C5X	4.13	1.48	1.41
2	B	500	FAD	P-O1P	3.91	1.64	1.50
2	A	1500	FAD	C6A-N6A	3.83	1.48	1.34
3	A	1501	NAD	C4N-C3N	3.78	1.45	1.39
2	A	1500	FAD	C2A-N1A	3.75	1.40	1.33
2	B	500	FAD	C5X-N5	3.70	1.41	1.35
2	A	1500	FAD	C4X-C10	3.67	1.42	1.38
2	B	500	FAD	C4X-C10	3.65	1.42	1.38
2	B	500	FAD	C2'-C3'	3.64	1.60	1.53

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Mol	Chain	Res	Type	Atoms	Z	Observed(Å)	Ideal(Å)
3	A	1501	NAD	PA-O5B	3.52	1.73	1.59
2	A	1500	FAD	C2B-C3B	3.49	1.62	1.53
2	A	1500	FAD	O4B-C4B	3.44	1.52	1.45
3	A	1501	NAD	C2N-C3N	3.40	1.44	1.39
3	B	501	NAD	C2N-C3N	3.35	1.44	1.39
3	A	1501	NAD	PN-O5D	3.28	1.72	1.59
3	B	501	NAD	PN-O1N	3.20	1.62	1.50
2	A	1500	FAD	C6-C7	3.20	1.45	1.37
3	B	501	NAD	C6A-N6A	3.16	1.45	1.34
2	A	1500	FAD	P-O5'	3.12	1.71	1.59
2	A	1500	FAD	C5X-N5	3.05	1.40	1.35
2	B	500	FAD	PA-O1A	3.04	1.61	1.50
2	B	500	FAD	C6-C7	3.01	1.45	1.37
2	A	1500	FAD	C9-C9A	2.99	1.46	1.40
2	B	500	FAD	C9-C9A	2.90	1.46	1.40
2	B	500	FAD	C4'-C3'	-2.88	1.48	1.53
2	B	500	FAD	C8M-C8	2.77	1.56	1.51
2	A	1500	FAD	PA-O5B	2.77	1.70	1.59
2	B	500	FAD	C2A-N1A	2.71	1.39	1.33
3	B	501	NAD	PA-O5B	2.71	1.70	1.59
3	B	501	NAD	O7N-C7N	-2.70	1.19	1.24
3	B	501	NAD	PN-O5D	2.66	1.70	1.59
3	A	1501	NAD	O4D-C1D	2.60	1.44	1.41
3	B	501	NAD	C2D-C3D	-2.50	1.46	1.53
2	B	500	FAD	O3'-C3'	2.47	1.48	1.43
2	B	500	FAD	PA-O2A	-2.46	1.43	1.55
3	A	1501	NAD	C6A-N6A	2.46	1.43	1.34
2	A	1500	FAD	O3'-C3'	2.45	1.48	1.43
3	A	1501	NAD	O4B-C1B	2.44	1.44	1.41
2	B	500	FAD	P-O5'	2.41	1.69	1.59
3	A	1501	NAD	C3B-C4B	2.36	1.59	1.53
2	B	500	FAD	O4B-C4B	2.36	1.50	1.45
3	A	1501	NAD	C5B-C4B	2.31	1.58	1.51
3	A	1501	NAD	C2A-N1A	2.22	1.38	1.33
3	A	1501	NAD	C5N-C4N	2.18	1.43	1.38
2	B	500	FAD	C8-C7	2.16	1.46	1.40
2	B	500	FAD	P-O2P	-2.12	1.45	1.55
3	A	1501	NAD	O4B-C4B	2.08	1.49	1.45
2	A	1500	FAD	C4A-N3A	2.04	1.38	1.35
2	A	1500	FAD	C8M-C8	2.04	1.55	1.51
3	A	1501	NAD	C2D-C1D	-2.01	1.50	1.53

All (88) bond angle outliers are listed below:

Mol	Chain	Res	Type	Atoms	Z	Observed(°)	Ideal(°)
2	B	500	FAD	O4B-C1B-C2B	21.87	138.88	106.93
2	A	1500	FAD	O4B-C1B-C2B	20.65	137.10	106.93
2	B	500	FAD	C1'-N10-C9A	14.16	129.44	118.29
2	A	1500	FAD	C5'-C4'-C3'	-13.18	86.74	112.20
3	B	501	NAD	C2N-C3N-C4N	9.56	129.10	118.26
3	B	501	NAD	C5D-C4D-C3D	9.30	150.04	115.18
2	B	500	FAD	O3'-C3'-C2'	8.77	129.99	108.81
2	A	1500	FAD	C1'-N10-C9A	8.75	125.18	118.29
2	A	1500	FAD	O3'-C3'-C4'	8.06	128.27	108.81
2	B	500	FAD	O4'-C4'-C5'	7.07	125.82	109.92
2	B	500	FAD	C4-N3-C2	6.97	121.03	115.14
3	A	1501	NAD	N3A-C2A-N1A	-6.77	118.09	128.68
3	B	501	NAD	O3D-C3D-C4D	6.73	130.51	111.05
3	B	501	NAD	C3N-C2N-N1N	-6.65	113.92	120.43
2	B	500	FAD	C1'-N10-C10	-6.63	112.47	118.41
3	A	1501	NAD	C1B-N9A-C4A	-6.04	116.03	126.64
3	A	1501	NAD	PN-O3-PA	-5.94	112.43	132.83
2	B	500	FAD	O2'-C2'-C3'	5.86	123.35	109.10
3	A	1501	NAD	O3D-C3D-C4D	5.57	127.14	111.05
2	A	1500	FAD	N3A-C2A-N1A	-5.38	120.27	128.68
2	B	500	FAD	N3A-C2A-N1A	-5.28	120.43	128.68
3	A	1501	NAD	C5D-C4D-C3D	5.07	134.19	115.18
3	B	501	NAD	N3A-C2A-N1A	-5.06	120.77	128.68
2	A	1500	FAD	O3'-C3'-C2'	-5.04	96.63	108.81
3	B	501	NAD	O2D-C2D-C1D	4.88	128.89	110.85
2	B	500	FAD	C5X-C9A-N10	4.75	121.16	117.72
3	B	501	NAD	C5N-C4N-C3N	-4.74	114.73	120.34
2	B	500	FAD	C4'-C3'-C2'	-4.74	103.50	113.36
3	A	1501	NAD	O2D-C2D-C1D	4.62	127.92	110.85
3	B	501	NAD	O2D-C2D-C3D	4.57	126.61	111.82
3	A	1501	NAD	C2N-C3N-C4N	4.55	123.41	118.26
3	A	1501	NAD	O5B-C5B-C4B	4.50	124.48	108.99
2	A	1500	FAD	O4'-C4'-C3'	4.49	120.01	109.10
3	A	1501	NAD	O3D-C3D-C2D	4.48	126.30	111.82
2	B	500	FAD	C2B-C3B-C4B	-4.41	94.08	102.64
3	A	1501	NAD	O2D-C2D-C3D	4.21	125.46	111.82
2	B	500	FAD	C5'-C4'-C3'	-4.18	104.13	112.20
3	A	1501	NAD	O7N-C7N-C3N	-3.94	114.92	119.63
2	B	500	FAD	C4X-C4-N3	-3.93	118.06	123.43
3	A	1501	NAD	C3N-C2N-N1N	-3.84	116.67	120.43
3	B	501	NAD	O7N-C7N-C3N	-3.82	115.06	119.63
2	A	1500	FAD	C1'-N10-C10	-3.72	115.08	118.41
3	A	1501	NAD	C3B-C2B-C1B	3.71	106.56	100.98

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Mol	Chain	Res	Type	Atoms	Z	Observed(°)	Ideal(°)
3	A	1501	NAD	C3D-C2D-C1D	3.69	106.53	100.98
3	B	501	NAD	C2N-N1N-C1D	3.54	127.01	119.14
2	A	1500	FAD	O3B-C3B-C2B	3.45	122.98	111.82
2	A	1500	FAD	C4-N3-C2	3.38	118.00	115.14
2	A	1500	FAD	C4X-C4-N3	-3.34	118.87	123.43
3	B	501	NAD	O7N-C7N-N7N	3.31	127.28	122.58
2	A	1500	FAD	C4X-N5-C5X	3.29	120.06	116.77
2	A	1500	FAD	C3B-C2B-C1B	-3.26	96.07	100.98
2	B	500	FAD	O4'-C4'-C3'	-3.24	101.23	109.10
2	A	1500	FAD	O2B-C2B-C3B	3.23	122.28	111.82
3	A	1501	NAD	O4B-C4B-C3B	-3.23	98.73	105.11
3	B	501	NAD	C2N-C3N-C7N	-3.17	110.25	119.46
3	B	501	NAD	C1B-N9A-C4A	-3.16	121.08	126.64
2	A	1500	FAD	O2'-C2'-C1'	3.13	117.14	109.59
3	B	501	NAD	O3D-C3D-C2D	3.12	121.93	111.82
3	B	501	NAD	C5N-C6N-N1N	3.10	124.85	120.40
3	A	1501	NAD	O4B-C4B-C5B	3.04	119.37	109.37
2	A	1500	FAD	C10-C4X-N5	-2.97	119.20	121.26
2	B	500	FAD	C9A-N10-C10	-2.94	118.05	121.91
2	A	1500	FAD	O3B-C3B-C4B	-2.90	102.65	111.05
2	A	1500	FAD	O4B-C4B-C5B	2.74	118.38	109.37
2	B	500	FAD	O3'-C3'-C4'	-2.68	102.35	108.81
2	A	1500	FAD	O4B-C4B-C3B	-2.62	99.94	105.11
2	A	1500	FAD	C2B-C3B-C4B	-2.61	97.56	102.64
2	B	500	FAD	O3B-C3B-C2B	2.59	120.20	111.82
3	B	501	NAD	O5D-PN-O1N	2.57	119.10	109.07
2	B	500	FAD	O2B-C2B-C1B	2.56	120.31	110.85
2	A	1500	FAD	O2B-C2B-C1B	2.53	120.20	110.85
3	A	1501	NAD	O4D-C4D-C5D	2.50	117.60	109.37
2	B	500	FAD	C6-C5X-C9A	2.48	122.31	119.05
3	A	1501	NAD	C2N-C3N-C7N	-2.44	112.39	119.46
3	A	1501	NAD	O7N-C7N-N7N	2.42	126.02	122.58
3	B	501	NAD	PN-O3-PA	-2.39	124.62	132.83
3	B	501	NAD	C2D-C3D-C4D	2.38	107.27	102.64
2	A	1500	FAD	C1B-N9A-C4A	2.34	130.75	126.64
2	A	1500	FAD	O5B-PA-O1A	-2.33	99.97	109.07
3	B	501	NAD	C3D-C2D-C1D	2.33	104.48	100.98
3	A	1501	NAD	O5D-C5D-C4D	2.32	116.98	108.99
2	B	500	FAD	P-O3P-PA	-2.31	124.90	132.83
2	B	500	FAD	C8M-C8-C9	-2.26	114.94	120.34
2	B	500	FAD	C7-C6-C5X	-2.25	118.03	121.22
2	A	1500	FAD	C4'-C3'-C2'	2.24	118.02	113.36

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Mol	Chain	Res	Type	Atoms	Z	Observed(°)	Ideal(°)
3	B	501	NAD	O4D-C1D-C2D	2.17	110.09	106.93
2	A	1500	FAD	P-O3P-PA	-2.09	125.67	132.83
2	B	500	FAD	O2B-C2B-C3B	2.06	118.49	111.82

All (12) chirality outliers are listed below:

Mol	Chain	Res	Type	Atom
3	B	501	NAD	C1D
3	B	501	NAD	C4D
3	B	501	NAD	C2D
3	B	501	NAD	C3D
3	A	1501	NAD	C1D
3	A	1501	NAD	C4D
3	A	1501	NAD	C2D
3	A	1501	NAD	C3D
2	B	500	FAD	C4'
2	B	500	FAD	C3'
2	A	1500	FAD	C4B
2	A	1500	FAD	C1B

All (32) torsion outliers are listed below:

Mol	Chain	Res	Type	Atoms
3	B	501	NAD	O4D-C4D-C5D-O5D
3	B	501	NAD	C2D-C1D-N1N-C2N
3	B	501	NAD	C2D-C1D-N1N-C6N
3	A	1501	NAD	C5B-O5B-PA-O3
3	A	1501	NAD	C5D-O5D-PN-O3
3	A	1501	NAD	C5D-O5D-PN-O2N
3	A	1501	NAD	C4D-C5D-O5D-PN
3	A	1501	NAD	O4D-C4D-C5D-O5D
3	A	1501	NAD	C2D-C1D-N1N-C2N
3	A	1501	NAD	C2D-C1D-N1N-C6N
2	B	500	FAD	O2'-C2'-C3'-C4'
2	A	1500	FAD	C5B-O5B-PA-O1A
2	A	1500	FAD	C4B-C5B-O5B-PA
2	A	1500	FAD	C2'-C3'-C4'-O4'
2	A	1500	FAD	O3'-C3'-C4'-O4'
2	A	1500	FAD	O3'-C3'-C4'-C5'
2	A	1500	FAD	C3'-C4'-C5'-O5'
2	A	1500	FAD	O4'-C4'-C5'-O5'
2	B	500	FAD	O2'-C2'-C3'-O3'

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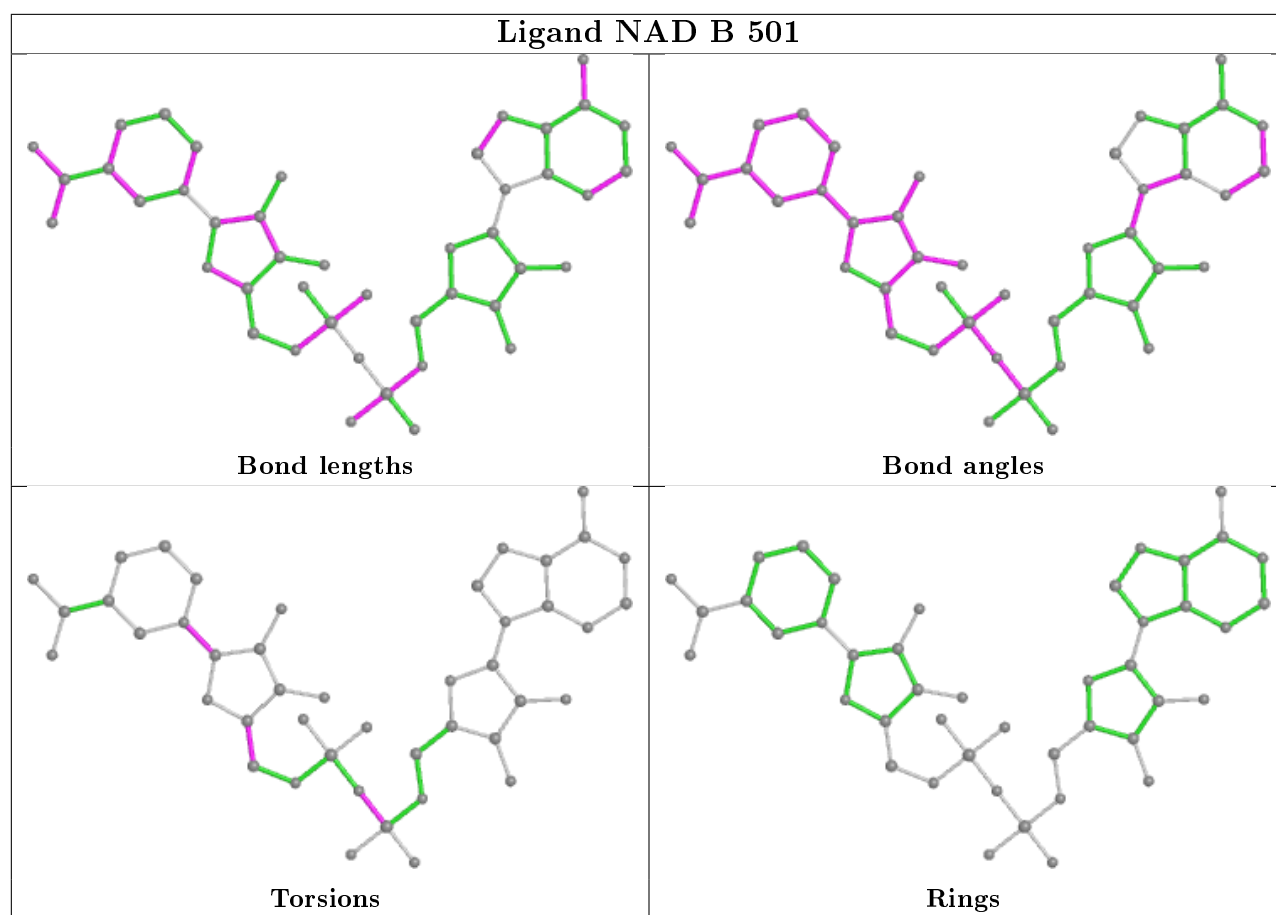
Mol	Chain	Res	Type	Atoms
2	A	1500	FAD	C2'-C3'-C4'-C5'
3	B	501	NAD	C3D-C4D-C5D-O5D
2	A	1500	FAD	O2'-C2'-C3'-C4'
3	B	501	NAD	PN-O3-PA-O5B
3	A	1501	NAD	PN-O3-PA-O5B
2	B	500	FAD	P-O3P-PA-O5B
2	A	1500	FAD	C5B-O5B-PA-O3P
3	A	1501	NAD	C5B-O5B-PA-O2A
3	A	1501	NAD	C5D-O5D-PN-O1N
2	A	1500	FAD	C5B-O5B-PA-O2A
3	A	1501	NAD	C4B-C5B-O5B-PA
2	A	1500	FAD	P-O3P-PA-O2A
2	A	1500	FAD	C3B-C4B-C5B-O5B

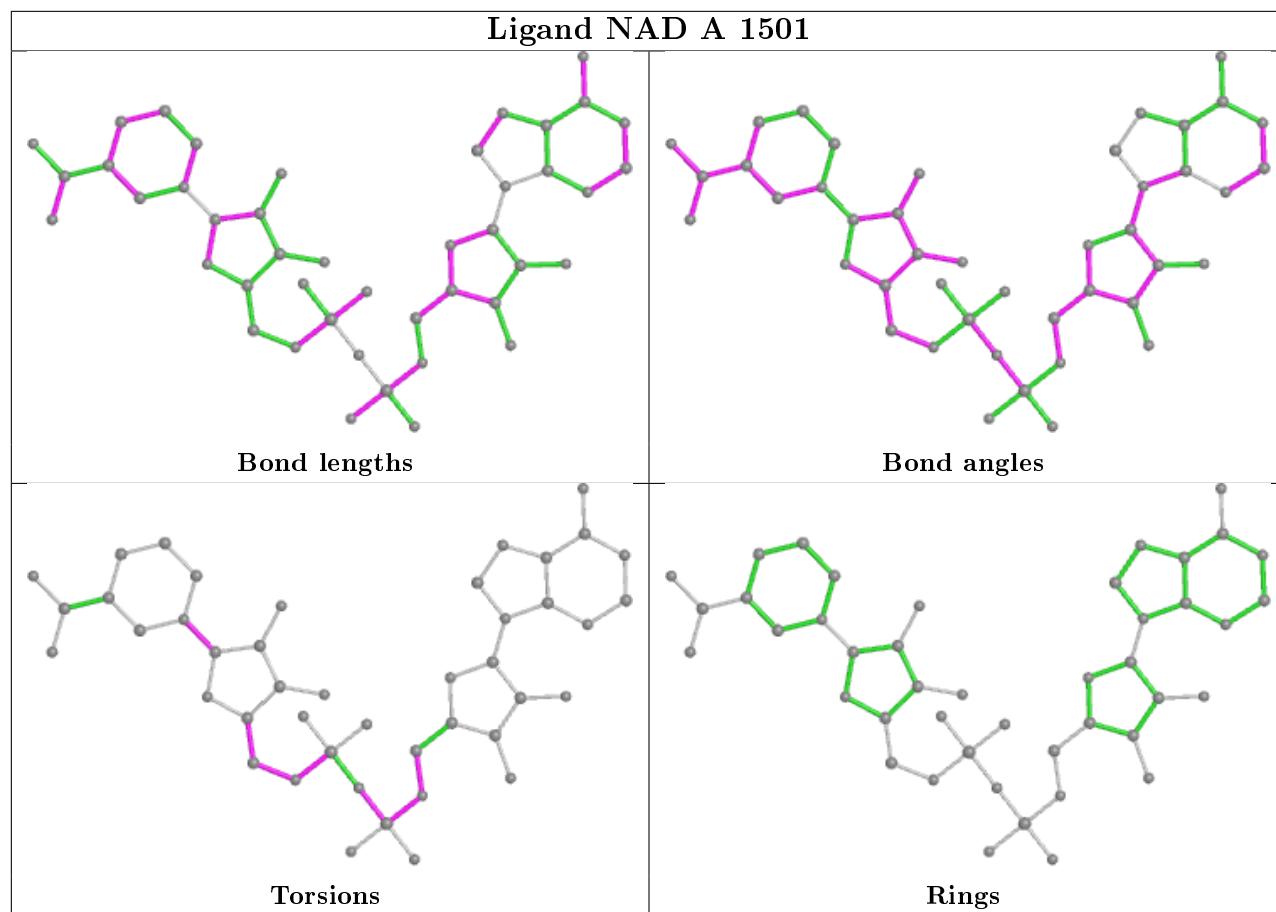
There are no ring outliers.

4 monomers are involved in 25 short contacts:

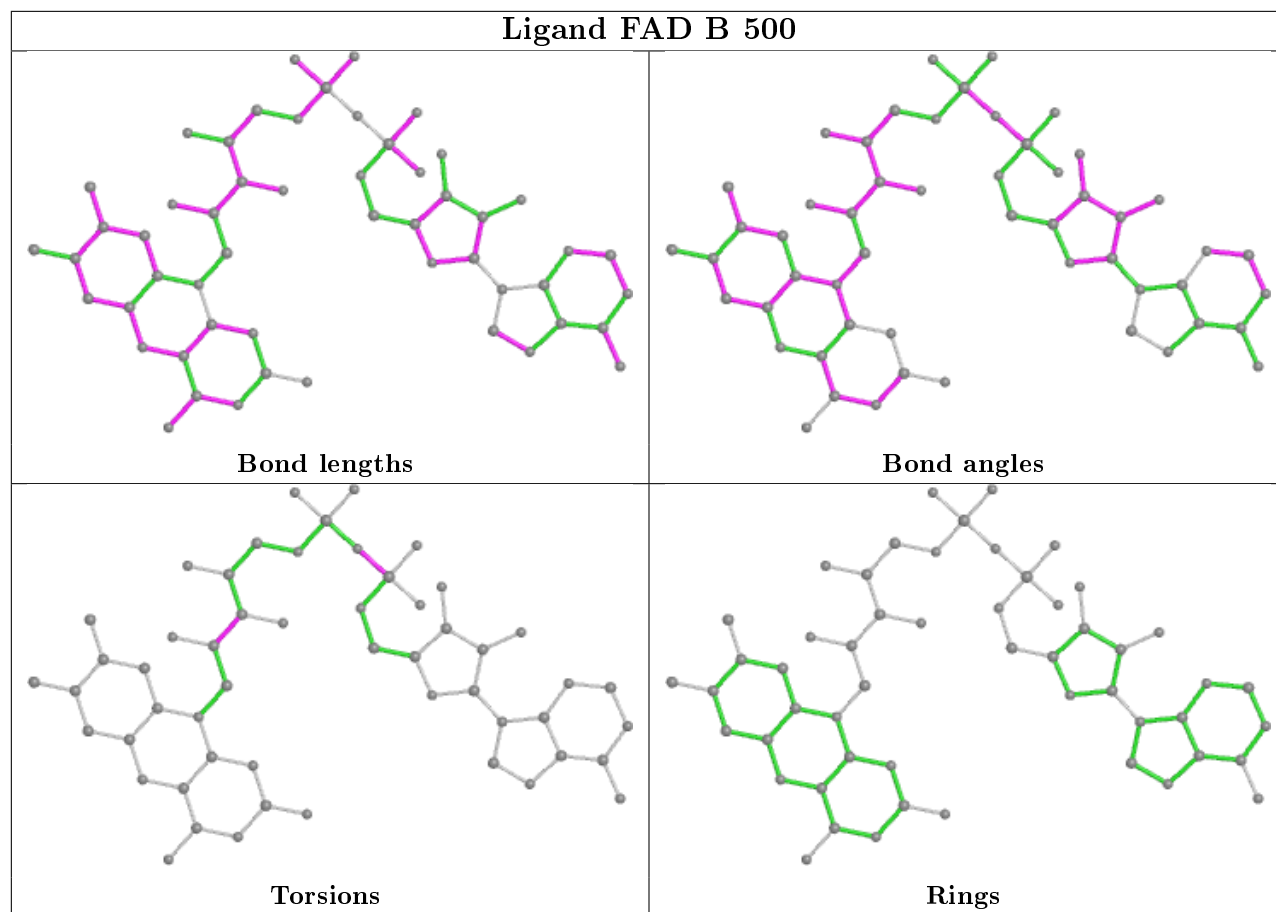
Mol	Chain	Res	Type	Clashes	Symm-Clashes
3	B	501	NAD	1	0
3	A	1501	NAD	10	0
2	B	500	FAD	2	0
2	A	1500	FAD	14	0

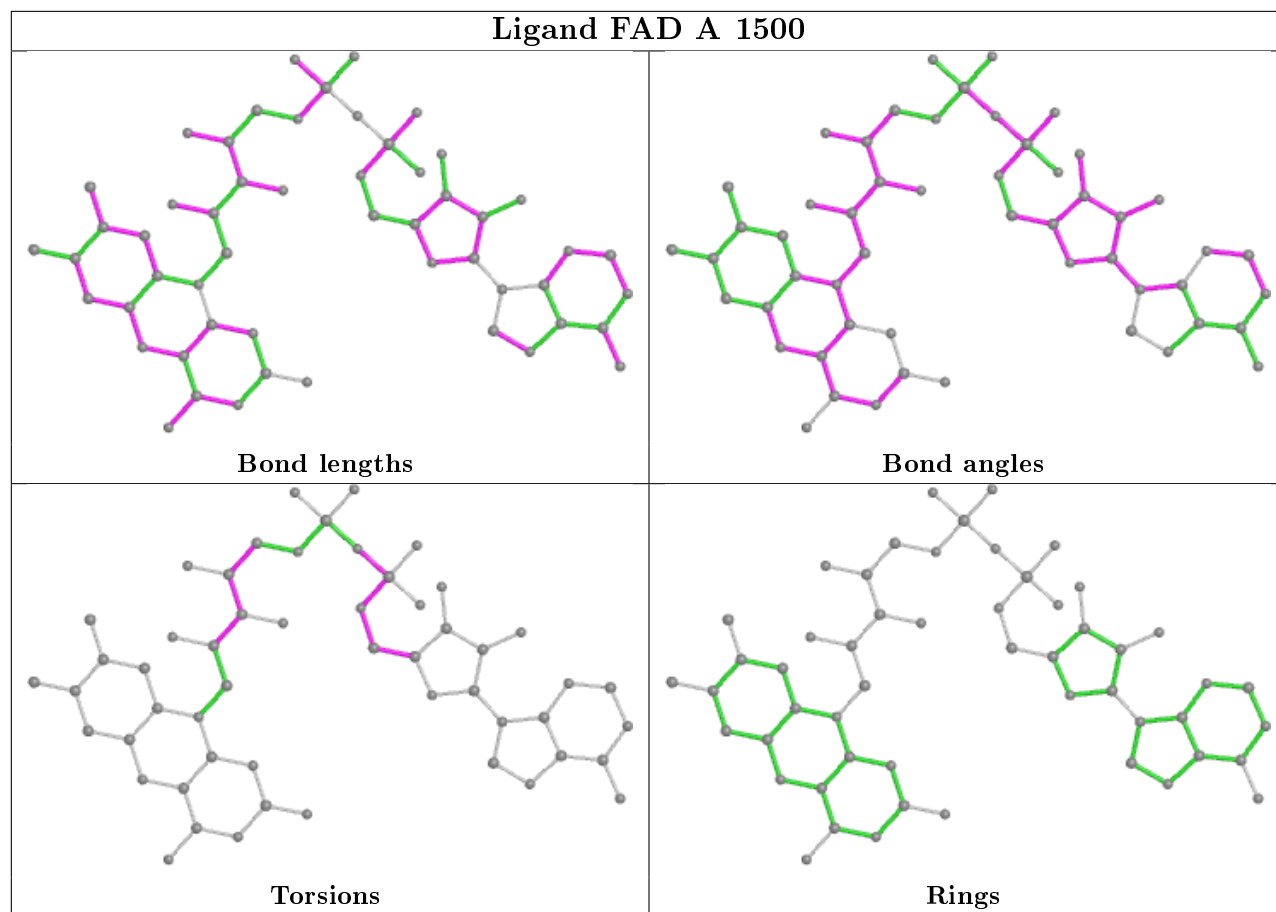
The following is a two-dimensional graphical depiction of Mogul quality analysis of bond lengths, bond angles, torsion angles, and ring geometry for all instances of the Ligand of Interest. In addition, ligands with molecular weight > 250 and outliers as shown on the validation Tables will also be included. 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.





Ligand FAD B 500





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	164/185 (88%)	-0.90	1 (0%) 89 88	18, 27, 49, 86	0
1	B	164/185 (88%)	-0.91	3 (1%) 68 66	18, 25, 44, 75	0
All	All	328/370 (88%)	-0.90	4 (1%) 79 78	18, 27, 49, 86	0

All (4) RSRZ outliers are listed below:

Mol	Chain	Res	Type	RSRZ
1	B	124	TYR	2.9
1	B	161	CYS	2.7
1	A	1015	GLU	2.1
1	B	159	GLU	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 carbohydrates 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	NAD	A	1501	44/44	0.76	0.15	35,49,76,96	0

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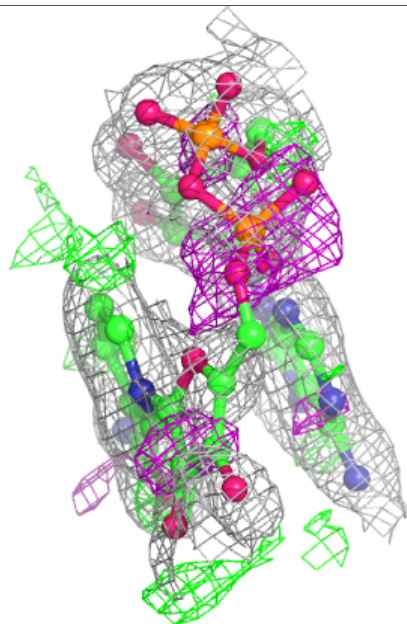
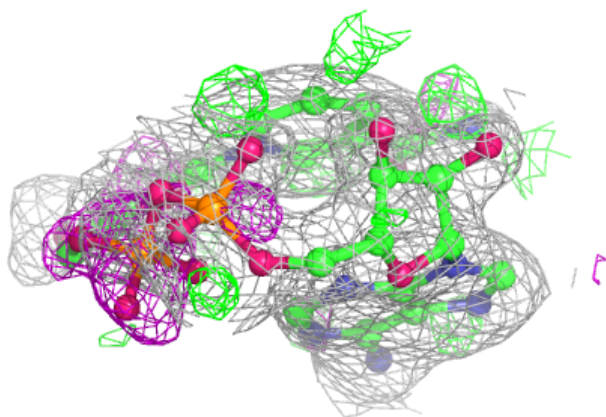
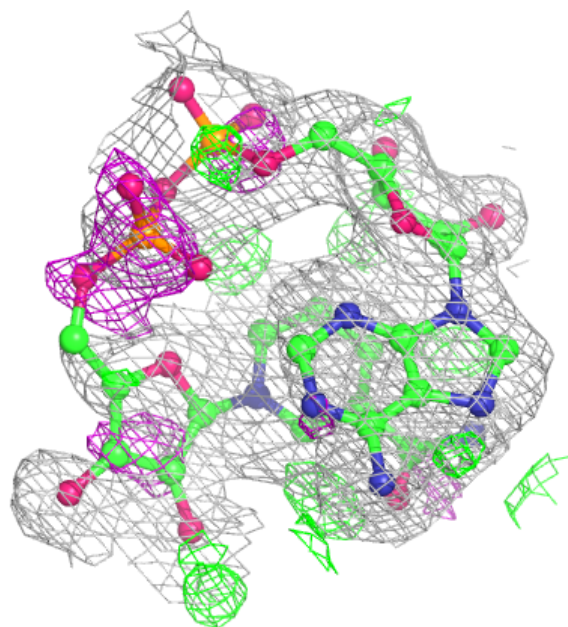
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Mol	Type	Chain	Res	Atoms	RSCC	RSR	B-factors(\AA^2)	Q<0.9
2	FAD	A	1500	53/53	0.87	0.13	19,33,64,71	0
2	FAD	B	500	53/53	0.92	0.10	19,31,65,69	0
3	NAD	B	501	44/44	0.96	0.08	26,32,47,59	0

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.

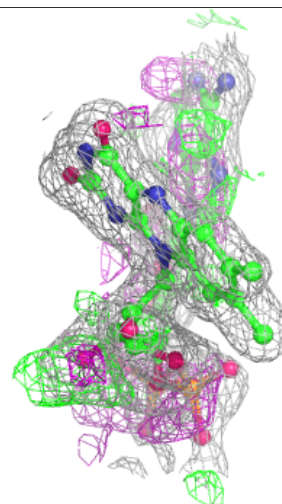
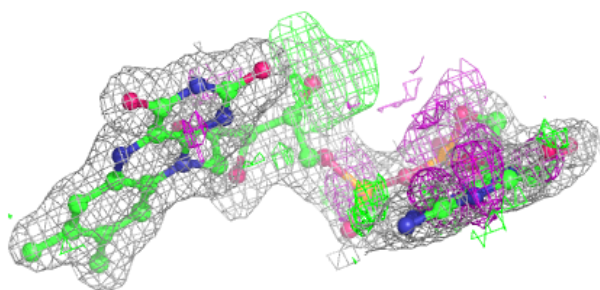
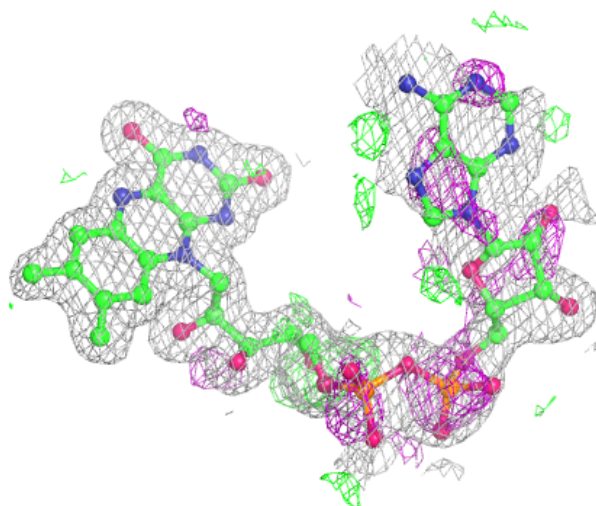
Electron density around NAD A 1501:

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



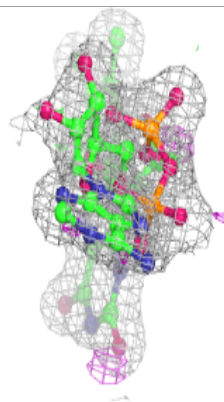
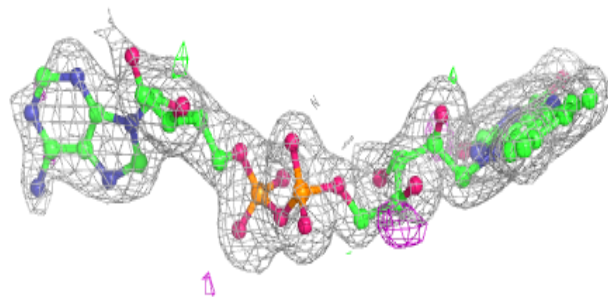
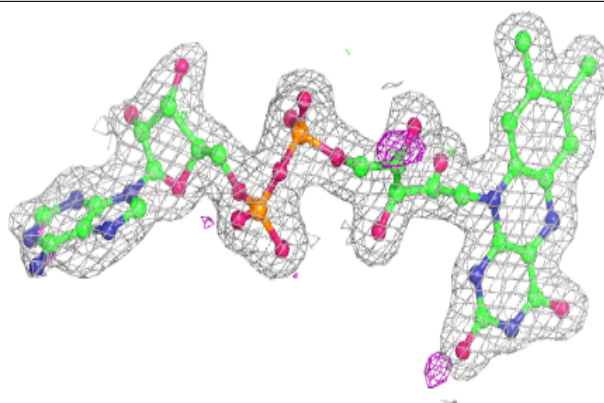
Electron density around FAD A 1500:

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



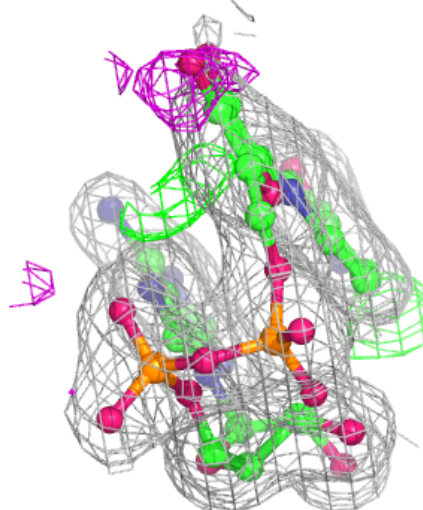
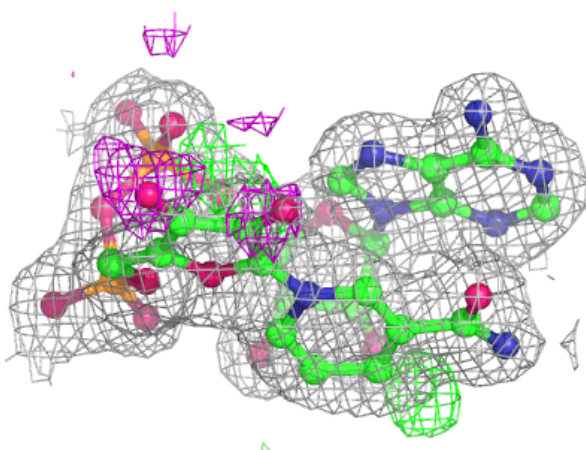
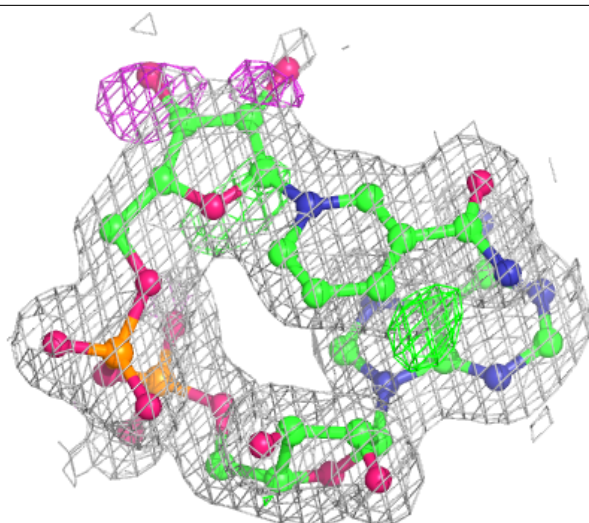
Electron density around FAD B 500:

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



Electron density around NAD 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)



6.5 Other polymers [i](#)

There are no such residues in this entry.