



Full wwPDB X-ray Structure Validation Report ⓘ

Mar 9, 2026 – 06:19 AM UTC

PDB ID : 6MYT / pdb_00006myt
Title : Avian mitochondrial complex II with Atpenin A5 bound, sidechain in pocket
Authors : Berry, E.A.; Huang, L.-S.
Deposited on : 2018-11-02
Resolution : 2.27 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

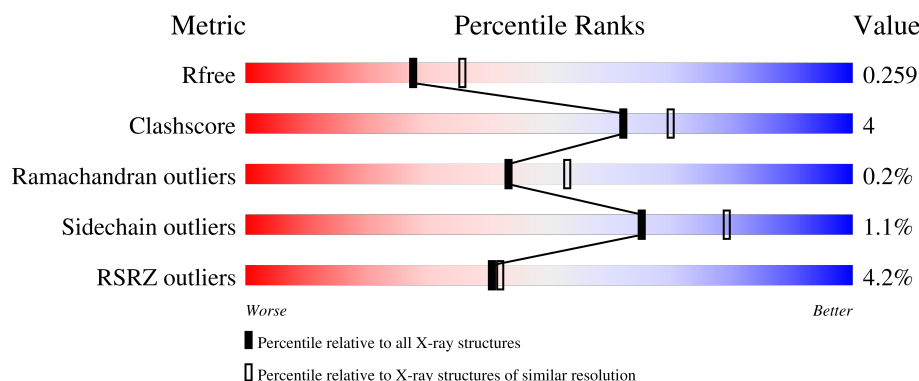
1 Overall quality at a glance

The following experimental techniques were used to determine the structure:

X-RAY DIFFRACTION

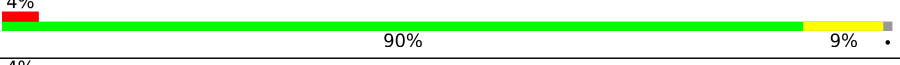
The reported resolution of this entry is 2.27 Å.

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	9078 (2.30-2.26)
Clashscore	190562	9802 (2.30-2.26)
Ramachandran outliers	187476	9690 (2.30-2.26)
Sidechain outliers	187428	9691 (2.30-2.26)
RSRZ outliers	180081	9085 (2.30-2.26)

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	621	
2	B	252	
3	C	140	
4	D	103	

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
6	OAA	A	1002	-	-	X	-
8	UNL	A	1019	-	-	-	X

2 Entry composition

There are 17 unique types of molecules in this entry. The entry contains 9156 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 Succinate dehydrogenase [ubiquinone] flavoprotein subunit, mitochondrial.

Mol	Chain	Residues	Atoms					ZeroOcc	AltConf	Trace
1	A	611	Total	C	N	O	S	0	1	0
			4721	2954	843	895	29			

- Molecule 2 is a protein called Succinate dehydrogenase [ubiquinone] iron-sulfur subunit, mitochondrial.

Mol	Chain	Residues	Atoms					ZeroOcc	AltConf	Trace
2	B	240	Total	C	N	O	S	0	0	0
			1928	1219	326	361	22			

- Molecule 3 is a protein called Succinate dehydrogenase cytochrome b, large subunit.

Mol	Chain	Residues	Atoms					ZeroOcc	AltConf	Trace
3	C	139	Total	C	N	O	S	0	0	0
			1076	707	178	186	5			

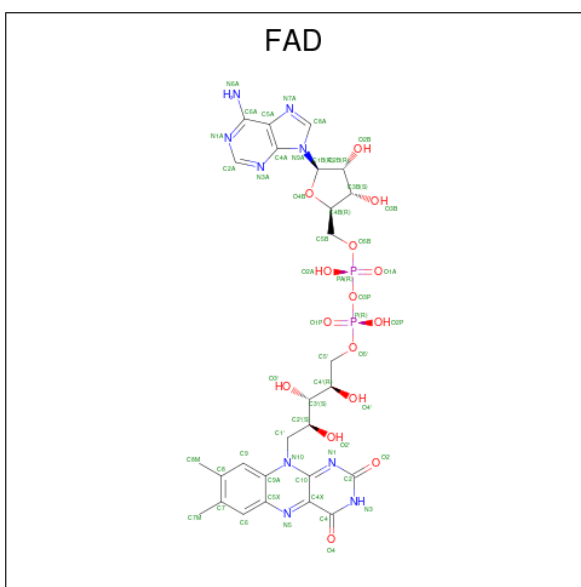
There are 2 discrepancies between the modelled and reference sequences:

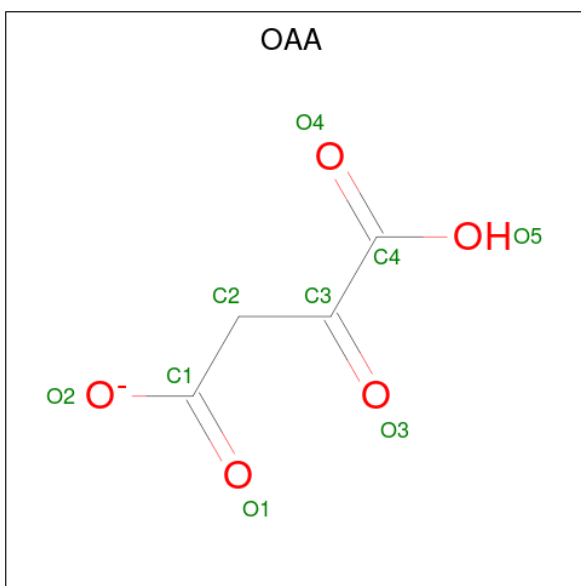
Chain	Residue	Modelled	Actual	Comment	Reference
C	139	ALA	SER	conflict	UNP D0VWW3
C	140	MET	GLU	conflict	UNP D0VWW3

- Molecule 4 is a protein called Succinate dehydrogenase [ubiquinone] cytochrome b small subunit, mitochondrial.

Mol	Chain	Residues	Atoms					ZeroOcc	AltConf	Trace
4	D	102	Total	C	N	O	S	0	0	0
			771	508	122	138	3			

- Molecule 5 is FLAVIN-ADENINE DINUCLEOTIDE (CCD ID: FAD) (formula: C₂₇H₃₃N₉O₁₅P₂).



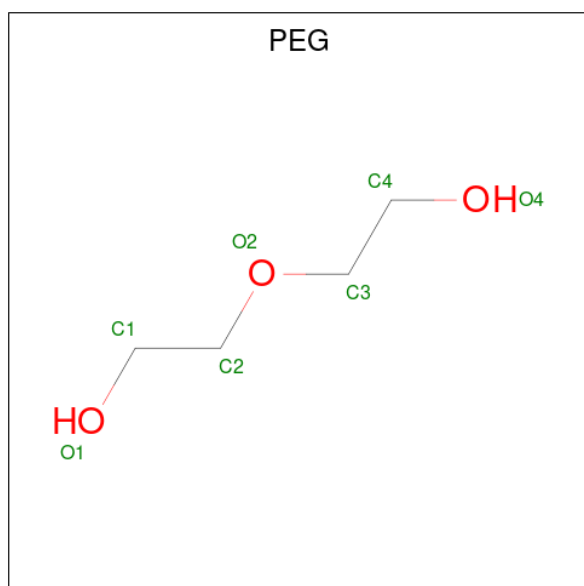


Mol	Chain	Residues	Atoms	ZeroOcc	AltConf
7	A	1	Total K 1 1	0	0

- Molecule 8 is UNKNOWN LIGAND (CCD ID: UNL) (formula:).

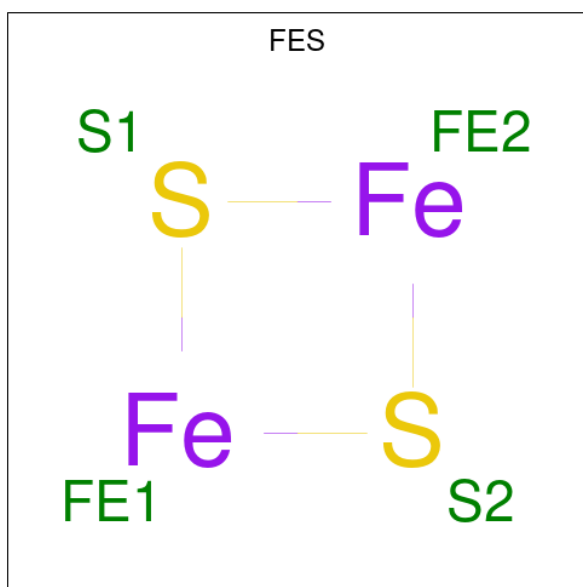
Mol	Chain	Residues	Atoms	ZeroOcc	AltConf
8	A	24	Total C Mn N O S 67 18 1 17 29 2	0	0
8	B	19	Total C N O S 49 11 12 25 1	0	1
8	C	9	Total C N O S 61 36 5 18 2	0	0
8	D	7	Total C O P 54 29 24 1	0	0

- Molecule 9 is DI(HYDROXYETHYL)ETHER (CCD ID: PEG) (formula: C₄H₁₀O₃).



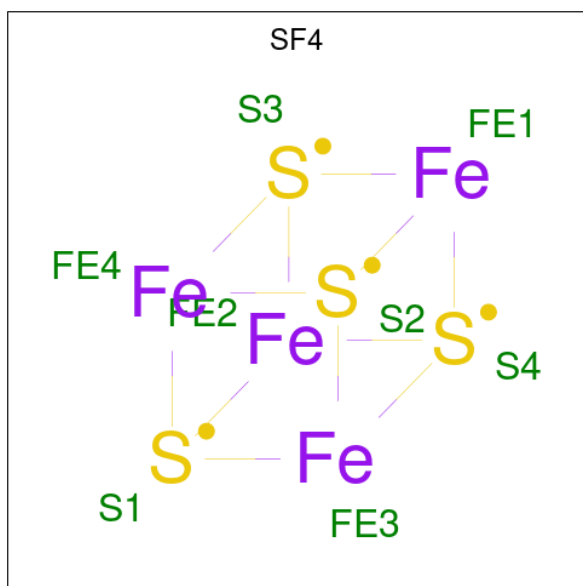
Mol	Chain	Residues	Atoms	ZeroOcc	AltConf
9	A	1	Total C O 5 3 2	0	0

- Molecule 10 is FE2/S2 (INORGANIC) CLUSTER (CCD ID: FES) (formula: Fe₂S₂).



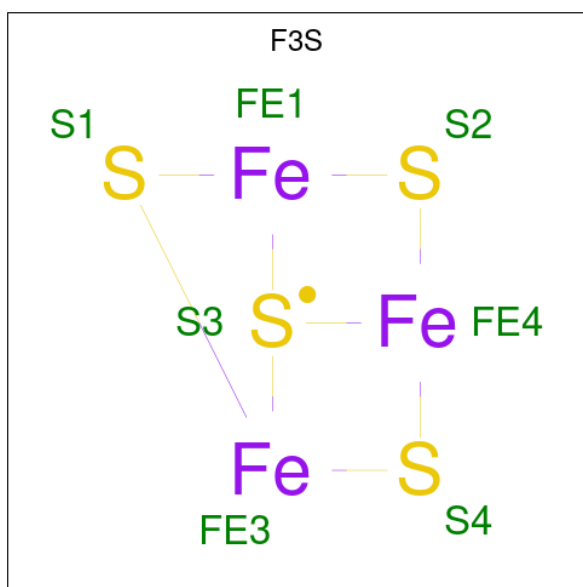
Mol	Chain	Residues	Atoms			ZeroOcc	AltConf
10	B	1	Total	Fe	S	0	0
			4	2	2		

- Molecule 11 is IRON/SULFUR CLUSTER (CCD ID: SF4) (formula: Fe_4S_4).



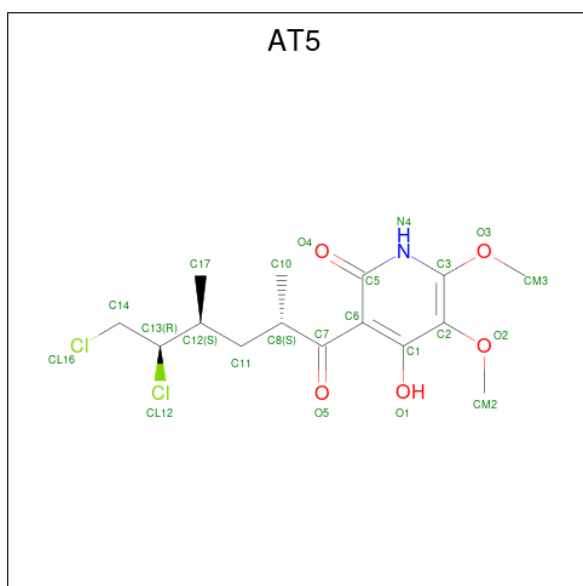
Mol	Chain	Residues	Atoms			ZeroOcc	AltConf
11	B	1	Total	Fe	S	0	0
			8	4	4		

- Molecule 12 is FE3-S4 CLUSTER (CCD ID: F3S) (formula: Fe_3S_4).



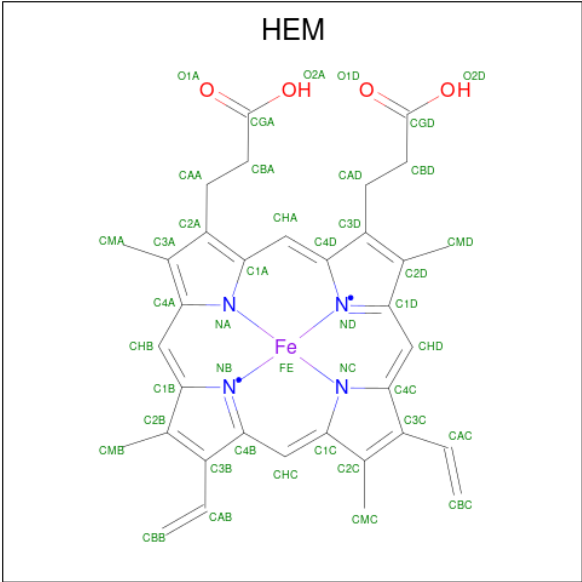
Mol	Chain	Residues	Atoms			ZeroOcc	AltConf
12	B	1	Total	Fe	S	0	0
			7	3	4		

- Molecule 13 is 3-[(2S,4S,5R)-5,6-DICHLORO-2,4-DIMETHYL-1-OXOHXYL]-4-HYDROXY-5,6-DIMETHOXY-2(1H)-PYRIDINONE (CCD ID: AT5) (formula: $C_{15}H_{21}Cl_2NO_5$).



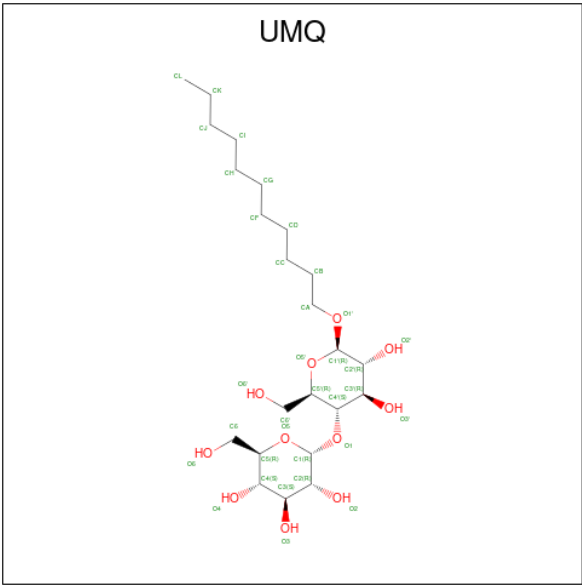
Mol	Chain	Residues	Atoms				ZeroOcc	AltConf
13	C	1	Total	C	Cl	N	O	
			23	15	2	1	5	

- Molecule 14 is PROTOPORPHYRIN IX CONTAINING FE (CCD ID: HEM) (formula: $C_{34}H_{32}FeN_4O_4$).



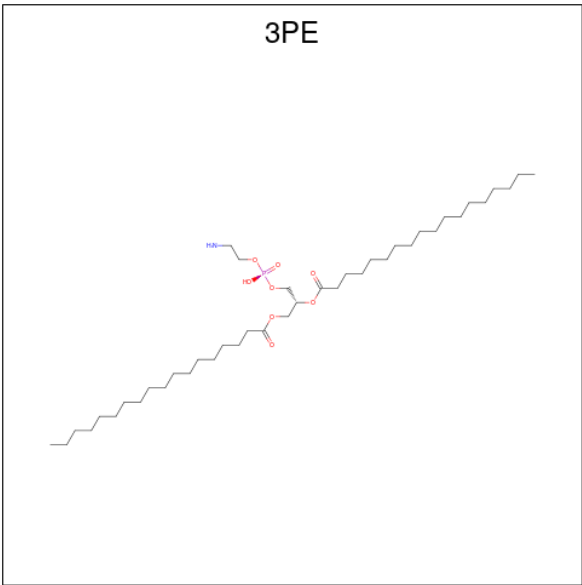
Mol	Chain	Residues	Atoms				ZeroOcc	AltConf
14	C	1	Total	C	Fe	N	O	
			41	32	1	4	4	

- Molecule 15 is UNDECYL-MALTOSIDE (CCD ID: UMQ) (formula: $C_{23}H_{44}O_{11}$).



Mol	Chain	Residues	Atoms		ZeroOcc	AltConf
15	C	1	Total	C O		
			34	23 11	0	0

- Molecule 16 is 1,2-Distearoyl-sn-glycerophosphoethanolamine (CCD ID: 3PE) (formula: $C_{41}H_{82}NO_8P$).



Mol	Chain	Residues	Atoms					ZeroOcc	AltConf
16	D	1	Total	C	N	O	P	0	0
			42	32	1	8	1		

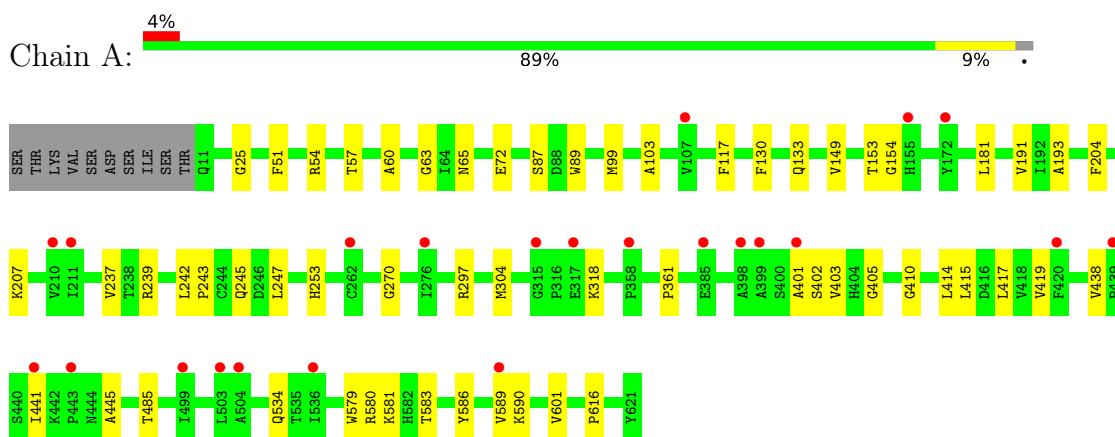
- Molecule 17 is water.

Mol	Chain	Residues	Atoms		ZeroOcc	AltConf
17	A	107	Total	O	0	1
			108	108		
17	B	53	Total	O	0	0
			53	53		
17	C	21	Total	O	0	0
			21	21		
17	D	19	Total	O	0	1
			20	20		

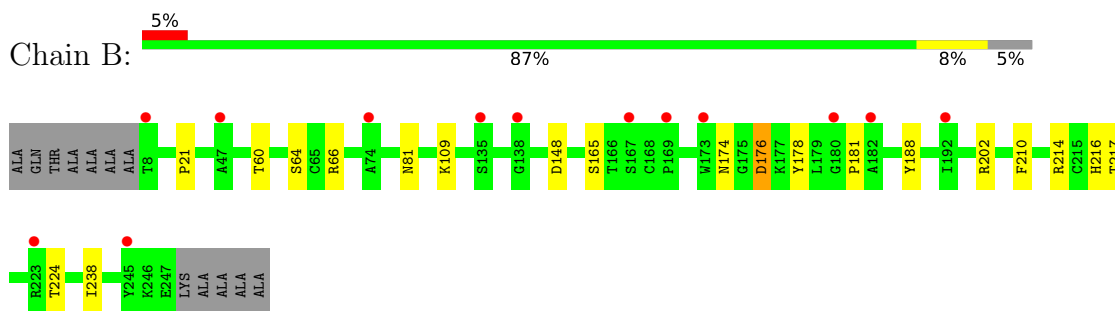
3 Residue-property plots

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.

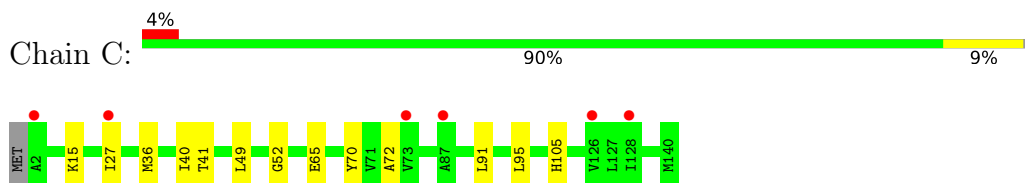
- Molecule 1: Succinate dehydrogenase [ubiquinone] flavoprotein subunit, mitochondrial



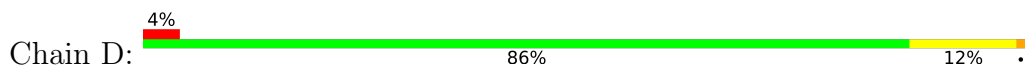
- Molecule 2: Succinate dehydrogenase [ubiquinone] iron-sulfur subunit, mitochondrial

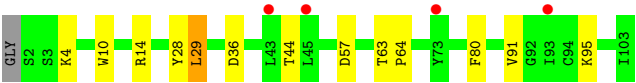


- Molecule 3: Succinate dehydrogenase cytochrome b, large subunit



- Molecule 4: Succinate dehydrogenase [ubiquinone] cytochrome b small subunit, mitochondrial





4 Data and refinement statistics

Property	Value	Source
Space group	P 21 21 21	Depositor
Cell constants a, b, c, α , β , γ	69.99Å 83.82Å 290.34Å 90.00° 90.00° 90.00°	Depositor
Resolution (Å)	25.19 – 2.27 25.19 – 2.27	Depositor EDS
% Data completeness (in resolution range)	87.8 (25.19-2.27) 81.5 (25.19-2.27)	Depositor EDS
R_{merge}	0.14	Depositor
R_{sym}	(Not available)	Depositor
$\langle I/\sigma(I) \rangle$ ¹	1.24 (at 2.26Å)	Xtriage
Refinement program	PHENIX (DEV_3150: ???)	Depositor
R, R_{free}	0.226 , 0.260 0.227 , 0.259	Depositor DCC
R_{free} test set	2045 reflections (2.56%)	wwPDB-VP
Wilson B-factor (Å ²)	42.3	Xtriage
Anisotropy	0.447	Xtriage
Bulk solvent k_{sol} (e/Å ³), B_{sol} (Å ²)	0.25 , 20.8	EDS
L-test for twinning ²	$\langle L \rangle = 0.41$, $\langle L^2 \rangle = 0.24$	Xtriage
Estimated twinning fraction	No twinning to report.	Xtriage
F_o, F_c correlation	0.93	EDS
Total number of atoms	9156	wwPDB-VP
Average B, all atoms (Å ²)	60.0	wwPDB-VP

Xtriage's analysis on translational NCS is as follows: *The largest off-origin peak in the Patterson function is 3.21% 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: F3S, UNL, PEG, SF4, AT5, FAD, OAA, K, UMQ, 3PE, MLZ, HEM, FES

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	0.09	0/4822	0.29	0/6528
2	B	0.10	0/1970	0.28	0/2656
3	C	0.08	0/1094	0.23	0/1486
4	D	0.08	0/794	0.20	0/1089
All	All	0.09	0/8680	0.27	0/11759

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	4721	0	4605	40	0
2	B	1928	0	1921	13	0
3	C	1076	0	1116	9	0
4	D	771	0	763	9	0
5	A	53	0	29	3	0
6	A	9	0	2	8	0
7	A	1	0	0	0	0
8	A	67	0	0	6	0
8	B	49	0	0	2	0

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Mol	Chain	Non-H	H(model)	H(added)	Clashes	Symm-Clashes
8	C	61	0	0	1	0
8	D	54	0	0	1	0
9	A	5	0	5	0	0
10	B	4	0	0	0	0
11	B	8	0	0	0	0
12	B	7	0	0	0	0
13	C	23	0	20	3	0
14	C	41	0	24	1	0
15	C	34	0	44	1	0
16	D	42	0	61	2	0
17	A	108	0	0	0	0
17	B	53	0	0	1	0
17	C	21	0	0	0	0
17	D	20	0	0	0	0
All	All	9156	0	8590	71	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 4.

All (71) 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:297:ARG:NH2	6:A:1002:OAA:H22	1.44	1.31
1:A:297:ARG:HH22	6:A:1002:OAA:C2	1.44	1.29
1:A:297:ARG:HH22	6:A:1002:OAA:C1	1.67	1.06
1:A:297:ARG:HH22	6:A:1002:OAA:H22	0.99	1.05
1:A:297:ARG:NH2	6:A:1002:OAA:C2	2.18	0.83
1:A:60:ALA:HB3	1:A:154:GLY:HA3	1.69	0.75
1:A:297:ARG:HH21	6:A:1002:OAA:H22	1.51	0.74
1:A:297:ARG:NH2	6:A:1002:OAA:C1	2.50	0.70
2:B:60:THR:OG1	2:B:109:LYS:NZ	2.29	0.65
2:B:214:ARG:NH1	4:D:57:ASP:OD1	2.26	0.65
3:C:27:ILE:HG12	13:C:202:AT5:H13	1.83	0.60
1:A:239:ARG:HG2	1:A:589:VAL:HG11	1.84	0.59
1:A:63:GLY:HA2	1:A:153:THR:HG21	1.84	0.59
4:D:44:THR:HG21	4:D:80:PHE:HB2	1.84	0.58
1:A:401:ALA:HB3	1:A:403:VAL:H	1.69	0.57
1:A:401:ALA:N	1:A:402:SER:HA	2.19	0.57
1:A:237:VAL:HG13	1:A:242:LEU:HB2	1.87	0.56
2:B:216:HIS:NE2	4:D:57:ASP:OD2	2.40	0.55
5:A:1001:FAD:O1P	8:A:1025:UNL:O	2.27	0.53

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Atom-1	Atom-2	Interatomic distance (Å)	Clash overlap (Å)
1:A:243:PRO:HB3	1:A:586:TYR:CZ	2.43	0.53
1:A:304:MET:HE2	1:A:361:PRO:HD3	1.90	0.53
3:C:52:GLY:HA3	16:D:201:3PE:H3G2	1.91	0.52
1:A:253:HIS:NE2	6:A:1002:OAA:O5	2.40	0.51
1:A:87:SER:HB2	1:A:405:GLY:HA3	1.93	0.51
1:A:181:LEU:HD23	1:A:191:VAL:HG12	1.92	0.51
4:D:91:VAL:HB	4:D:95:LYS:HG2	1.93	0.50
2:B:174:ASN:ND2	17:B:1107:HOH:O	2.43	0.50
1:A:580:ARG:O	8:A:1010:UNL:S2	2.70	0.50
1:A:57:THR:OG1	5:A:1001:FAD:O2A	2.22	0.50
2:B:148:ASP:O	8:B:1019:UNL:O	2.29	0.50
2:B:188:TYR:HB2	2:B:238:ILE:HD11	1.93	0.50
2:B:176:ASP:OD1	2:B:176:ASP:N	2.40	0.49
3:C:40:ILE:HD13	13:C:202:AT5:H103	1.95	0.49
4:D:36:ASP:OD2	8:D:208:UNL:O	2.31	0.49
2:B:165:SER:HA	2:B:181:PRO:HD2	1.96	0.48
1:A:410:GLY:O	8:A:1024:UNL:O	2.32	0.48
1:A:117:PHE:HA	1:A:149:VAL:HG22	1.95	0.48
1:A:401:ALA:HB3	1:A:403:VAL:N	2.29	0.47
2:B:178:TYR:CD1	2:B:214:ARG:HB2	2.49	0.47
3:C:65:GLU:HB2	3:C:70:TYR:CZ	2.49	0.47
3:C:72:ALA:O	8:C:212:UNL:O	2.33	0.47
1:A:103:ALA:HA	1:A:415:LEU:HD11	1.97	0.47
14:C:201:HEM:HBD1	14:C:201:HEM:HHA	1.96	0.47
2:B:81:ASN:O	2:B:224:THR:OG1	2.32	0.47
1:A:247:LEU:HD12	1:A:534:GLN:HB2	1.97	0.46
3:C:36:MET:HE2	13:C:202:AT5:H142	1.98	0.46
2:B:202:ARG:O	8:B:1020:UNL:O	2.35	0.45
3:C:49:LEU:HD11	3:C:95:LEU:HA	1.98	0.45
1:A:441:ILE:HD12	1:A:445:ALA:HB3	1.99	0.45
1:A:65:ASN:CG	1:A:133:GLN:HE22	2.25	0.45
2:B:210:PHE:HA	2:B:214:ARG:HG2	2.00	0.44
1:A:51:PHE:HB3	1:A:54:ARG:HG2	2.00	0.44
1:A:25:GLY:HA2	5:A:1001:FAD:H1B	1.99	0.44
1:A:414:LEU:HD23	1:A:417:LEU:HD12	1.99	0.44
2:B:21:PRO:HD2	2:B:109:LYS:HD2	1.99	0.44
1:A:579:TRP:NE1	8:A:1014:UNL:O2	2.44	0.43
4:D:10:TRP:O	4:D:14:ARG:HG2	2.18	0.43
4:D:63:THR:HB	4:D:64:PRO:HD3	2.00	0.43
1:A:99:MET:HA	1:A:419:VAL:HG11	2.01	0.42
1:A:54:ARG:HG3	8:A:1020:UNL:N3	2.35	0.42

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Atom-1	Atom-2	Interatomic distance (Å)	Clash overlap (Å)
1:A:581:LYS:HA	1:A:601:VAL:HG23	2.02	0.42
1:A:89:TRP:CE2	1:A:616:PRO:HA	2.55	0.42
4:D:28:TYR:HD1	4:D:29:LEU:HD23	1.85	0.42
4:D:4:LYS:HE2	4:D:4:LYS:HB3	1.91	0.41
1:A:193:ALA:HB3	1:A:204:PHE:HE1	1.85	0.41
3:C:41:THR:HG21	15:C:203:UMQ:HK1	2.02	0.41
1:A:245:GLN:HA	1:A:583:THR:O	2.21	0.41
1:A:590:LYS:HE2	1:A:590:LYS:HB3	1.86	0.41
1:A:270:GLY:O	8:A:1028:UNL:O	2.38	0.40
1:A:207:LYS:HE2	1:A:207:LYS:HB3	1.90	0.40
3:C:49:LEU:HD22	16:D:201:3PE:H3D2	2.04	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	610/621 (98%)	583 (96%)	27 (4%)	0	100	100
2	B	238/252 (94%)	228 (96%)	8 (3%)	2 (1%)	16	18
3	C	136/140 (97%)	135 (99%)	1 (1%)	0	100	100
4	D	100/103 (97%)	99 (99%)	1 (1%)	0	100	100
All	All	1084/1116 (97%)	1045 (96%)	37 (3%)	2 (0%)	43	53

All (2) Ramachandran outliers are listed below:

Mol	Chain	Res	Type
2	B	64	SER
2	B	66	ARG

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	496/506 (98%)	491 (99%)	5 (1%)	68	81
2	B	216/219 (99%)	214 (99%)	2 (1%)	70	82
3	C	116/117 (99%)	114 (98%)	2 (2%)	53	70
4	D	78/79 (99%)	77 (99%)	1 (1%)	61	76
All	All	906/921 (98%)	896 (99%)	10 (1%)	65	79

All (10) residues with a non-rotameric sidechain are listed below:

Mol	Chain	Res	Type
1	A	72	GLU
1	A	130	PHE
1	A	318	LYS
1	A	438	VAL
1	A	485	THR
2	B	176	ASP
2	B	217	THR
3	C	91	LEU
3	C	105	HIS
4	D	29	LEU

Sometimes sidechains can be flipped to improve hydrogen bonding and reduce clashes. All (4) such sidechains are listed below:

Mol	Chain	Res	Type
1	A	159	HIS
1	A	498	GLN
2	B	117	ASN
2	B	144	GLN

5.3.3 RNA ⓘ

There are no RNA molecules in this entry.

5.4 Non-standard residues in protein, DNA, RNA chains ⓘ

1 non-standard protein/DNA/RNA residue 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	$\# Z > 2$
3	MLZ	C	15	3	8,9,10	0.64	0	4,9,11	1.59	1 (25%)

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	MLZ	C	15	3	-	1/7/8/10	-

There are no bond length outliers.

All (1) bond angle outliers are listed below:

Mol	Chain	Res	Type	Atoms	Z	Observed(°)	Ideal(°)
3	C	15	MLZ	CM-NZ-CE	2.98	120.31	112.01

There are no chirality outliers.

All (1) torsion outliers are listed below:

Mol	Chain	Res	Type	Atoms
3	C	15	MLZ	C-CA-CB-CG

There are no ring outliers.

No monomer is involved in short contacts.

5.5 Carbohydrates ⓘ

There are no oligosaccharides in this entry.

5.6 Ligand geometry

Of 71 ligands modelled in this entry, 1 is monoatomic and 60 are unknown - leaving 10 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	FAD	A	1001	1	58,58,58	1.08	6 (10%)	85,89,89	1.46	13 (15%)
6	OAA	A	1002	-	8,8,8	2.54	2 (25%)	8,10,10	1.90	4 (50%)
9	PEG	A	1005	-	4,4,6	0.43	0	3,3,5	0.33	0
11	SF4	B	1002	2	0,12,12	-	-	-	-	-
13	AT5	C	202	-	20,23,23	1.26	3 (15%)	21,32,32	1.39	3 (14%)
15	UMQ	C	203	-	35,35,35	0.41	0	46,46,46	0.67	1 (2%)
16	3PE	D	201	-	41,41,50	1.04	2 (4%)	44,46,55	1.03	2 (4%)
14	HEM	C	201	4,3	48,48,50	1.46	9 (18%)	66,80,82	1.19	6 (9%)
12	F3S	B	1003	2	0,9,9	-	-	-	-	-
10	FES	B	1001	2	0,4,4	-	-	-	-	-

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	FAD	A	1001	1	-	6/34/50/50	0/6/6/6
6	OAA	A	1002	-	-	3/8/8/8	-
9	PEG	A	1005	-	-	0/2/2/4	-
13	AT5	C	202	-	-	15/20/22/22	0/1/1/1
15	UMQ	C	203	-	-	1/20/60/60	0/2/2/2
11	SF4	B	1002	2	-	-	0/6/5/5
16	3PE	D	201	-	-	7/45/45/54	-
14	HEM	C	201	4,3	-	3/10/50/54	-
12	F3S	B	1003	2	-	-	0/3/3/3
10	FES	B	1001	2	-	-	0/1/1/1

All (22) bond length outliers are listed below:

Mol	Chain	Res	Type	Atoms	Z	Observed(Å)	Ideal(Å)
6	A	1002	OAA	O3-C3	5.13	1.33	1.23
14	C	201	HEM	FE-ND	4.47	2.08	1.94
16	D	201	3PE	O31-C31	4.28	1.45	1.33
16	D	201	3PE	O21-C21	4.27	1.46	1.34
14	C	201	HEM	FE-NC	3.80	2.07	1.95
6	A	1002	OAA	C2-C3	-3.64	1.37	1.51
14	C	201	HEM	FE-NB	3.33	2.05	1.94
13	C	202	AT5	C6-C1	2.95	1.49	1.40
5	A	1001	FAD	C5A-C6A	2.95	1.49	1.41
5	A	1001	FAD	C4-N3	-2.72	1.33	1.38
14	C	201	HEM	FE-NA	2.47	2.03	1.95
13	C	202	AT5	C6-C5	2.35	1.49	1.44
5	A	1001	FAD	C8A-N7A	2.23	1.36	1.31
13	C	202	AT5	C5-N4	-2.18	1.34	1.38
5	A	1001	FAD	PA-O3P	2.10	1.61	1.59
14	C	201	HEM	CAC-C3C	2.08	1.55	1.50
5	A	1001	FAD	P-O3P	2.07	1.61	1.59
5	A	1001	FAD	C5A-N7A	-2.06	1.35	1.39
14	C	201	HEM	CMC-C2C	2.03	1.54	1.50
14	C	201	HEM	CMA-C3A	2.02	1.54	1.50
14	C	201	HEM	CAB-C3B	2.02	1.54	1.50
14	C	201	HEM	CMD-C2D	2.00	1.54	1.50

All (29) bond angle outliers are listed below:

Mol	Chain	Res	Type	Atoms	Z	Observed(°)	Ideal(°)
5	A	1001	FAD	C5A-C4A-N3A	-5.07	119.73	126.72
13	C	202	AT5	C1-C6-C7	4.44	123.07	118.11
5	A	1001	FAD	C4-N3-C2	-4.32	117.97	125.64
16	D	201	3PE	O21-C21-C22	4.03	120.21	111.48
5	A	1001	FAD	N3A-C4A-N9A	3.46	133.05	127.17
5	A	1001	FAD	C4X-C4-N3	3.43	121.97	113.25
5	A	1001	FAD	N9A-C8A-N7A	-3.29	109.27	113.94
5	A	1001	FAD	C4'-C3'-C2'	-3.01	108.56	113.57
14	C	201	HEM	C1B-NB-C4B	2.83	108.56	105.21
5	A	1001	FAD	O4-C4-C4X	-2.80	119.15	126.53
5	A	1001	FAD	C2A-N3A-C4A	2.76	118.56	111.83
5	A	1001	FAD	C4A-N9A-C8A	2.74	108.62	105.74
14	C	201	HEM	C4D-ND-C1D	2.62	108.31	105.21
6	A	1002	OAA	O4-C4-C3	-2.62	118.56	121.81
16	D	201	3PE	O31-C31-C32	2.54	119.58	111.83
6	A	1002	OAA	O2-C1-C2	2.54	122.37	114.51

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Mol	Chain	Res	Type	Atoms	Z	Observed(°)	Ideal(°)
5	A	1001	FAD	C4A-C5A-N7A	-2.44	107.79	110.58
6	A	1002	OAA	O3-C3-C2	2.40	124.10	120.41
13	C	202	AT5	C6-C5-N4	2.38	121.65	115.10
5	A	1001	FAD	C4X-C10-N1	-2.35	118.83	124.59
5	A	1001	FAD	C5A-N7A-C8A	2.32	107.10	103.45
14	C	201	HEM	C2A-C1A-NA	-2.27	107.63	110.15
14	C	201	HEM	C3D-C4D-ND	-2.27	107.68	110.17
15	C	203	UMQ	C1-O1-C4'	-2.20	112.77	117.98
13	C	202	AT5	O4-C5-C6	-2.13	119.31	125.69
6	A	1002	OAA	O1-C1-C2	-2.12	116.07	122.11
14	C	201	HEM	C3B-C4B-NB	-2.09	107.49	109.90
14	C	201	HEM	C2B-C1B-NB	-2.05	107.49	109.84
5	A	1001	FAD	C10-N1-C2	2.04	121.27	116.85

There are no chirality outliers.

All (35) torsion outliers are listed below:

Mol	Chain	Res	Type	Atoms
5	A	1001	FAD	N10-C1'-C2'-O2'
5	A	1001	FAD	N10-C1'-C2'-C3'
6	A	1002	OAA	C2-C3-C4-O4
6	A	1002	OAA	C2-C3-C4-O5
13	C	202	AT5	O5-C7-C8-C10
13	C	202	AT5	C6-C7-C8-C10
13	C	202	AT5	C1-C6-C7-O5
13	C	202	AT5	C5-C6-C7-C8
13	C	202	AT5	C1-C6-C7-C8
13	C	202	AT5	C8-C11-C12-C17
13	C	202	AT5	C11-C12-C13-CL12
13	C	202	AT5	C11-C12-C13-C14
13	C	202	AT5	C17-C12-C13-CL12
13	C	202	AT5	C17-C12-C13-C14
13	C	202	AT5	C12-C13-C14-CL16
16	D	201	3PE	O22-C21-O21-C2
16	D	201	3PE	C22-C21-O21-C2
16	D	201	3PE	C31-C32-C33-C34
15	C	203	UMQ	CA-CB-CC-CD
14	C	201	HEM	C4D-C3D-CAD-CBD
13	C	202	AT5	C5-C6-C7-O5
14	C	201	HEM	C2D-C3D-CAD-CBD
5	A	1001	FAD	PA-O3P-P-O5'
6	A	1002	OAA	O3-C3-C4-O4

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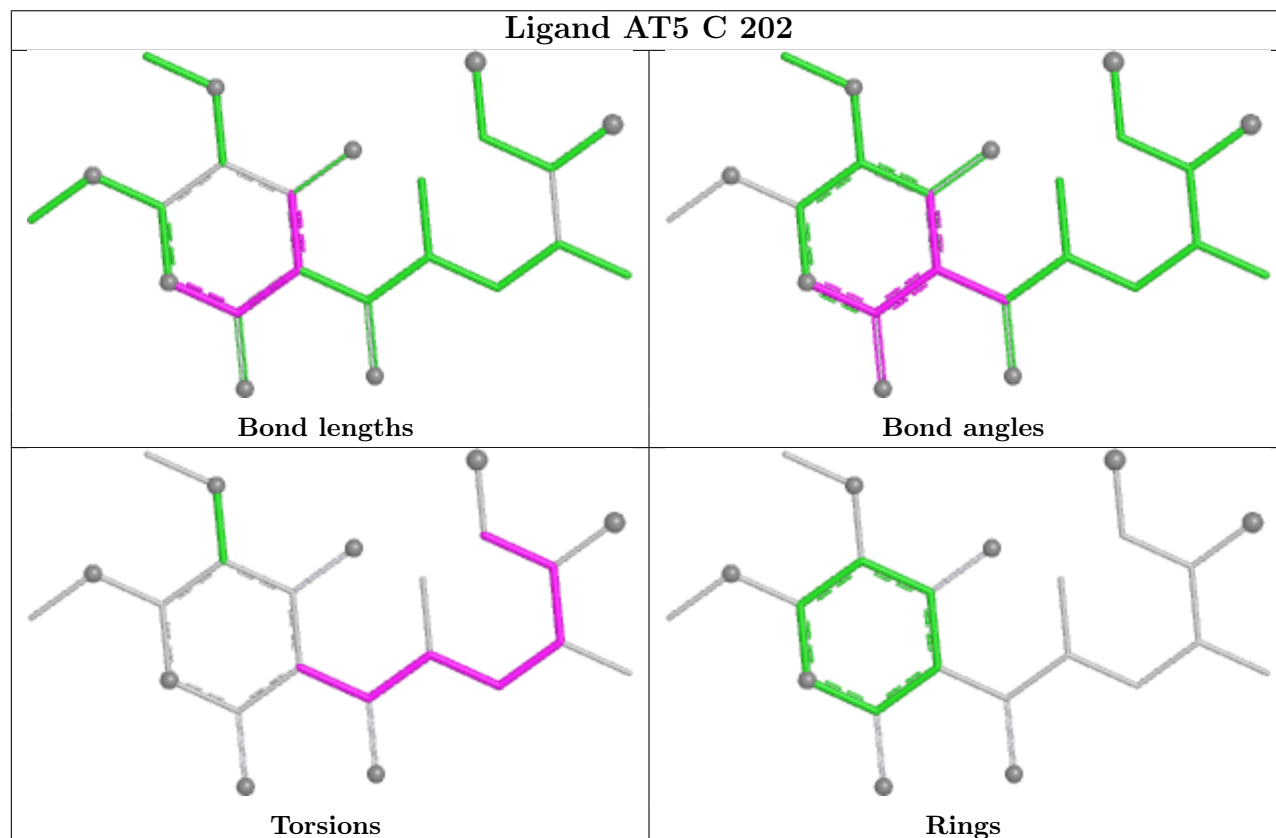
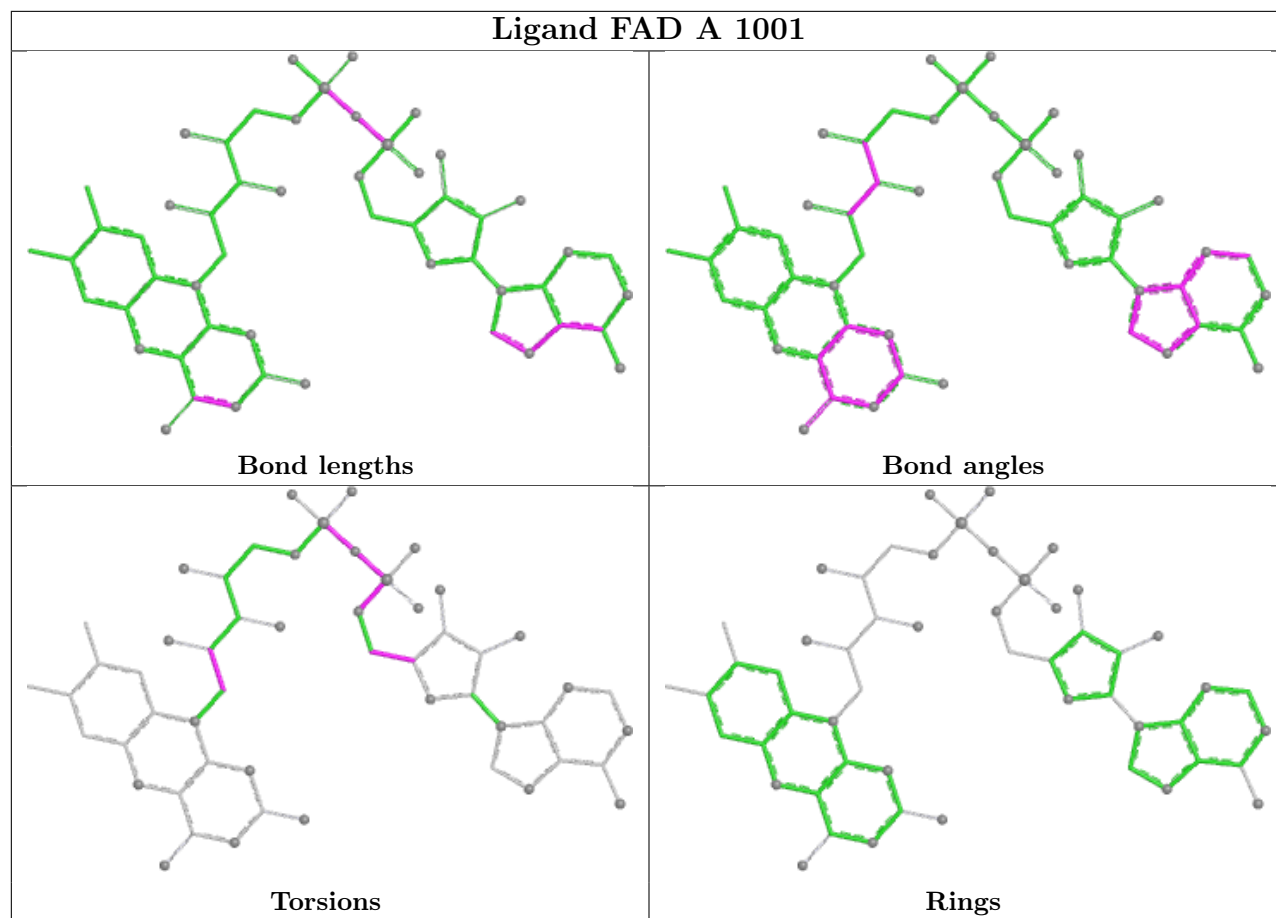
Mol	Chain	Res	Type	Atoms
13	C	202	AT5	C12-C11-C8-C10
5	A	1001	FAD	C5B-O5B-PA-O1A
16	D	201	3PE	C3C-C3D-C3E-C3F
5	A	1001	FAD	P-O3P-PA-O2A
13	C	202	AT5	C12-C11-C8-C7
16	D	201	3PE	C39-C3A-C3B-C3C
16	D	201	3PE	O21-C2-C3-O31
16	D	201	3PE	C22-C23-C24-C25
13	C	202	AT5	C8-C11-C12-C13
5	A	1001	FAD	O4B-C4B-C5B-O5B
14	C	201	HEM	CAA-CBA-CGA-O2A

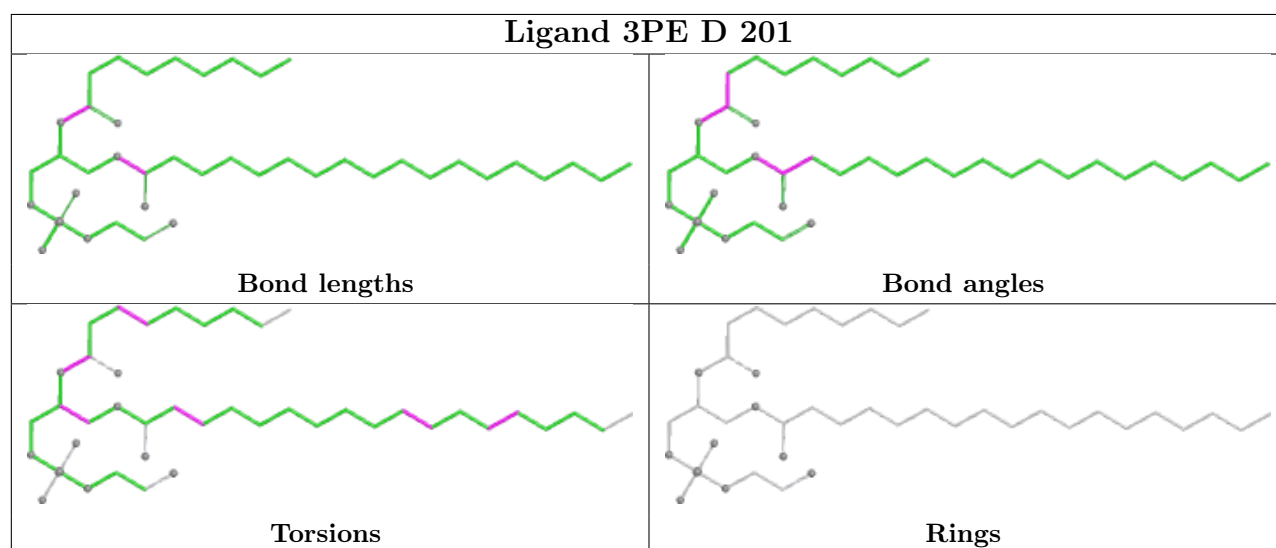
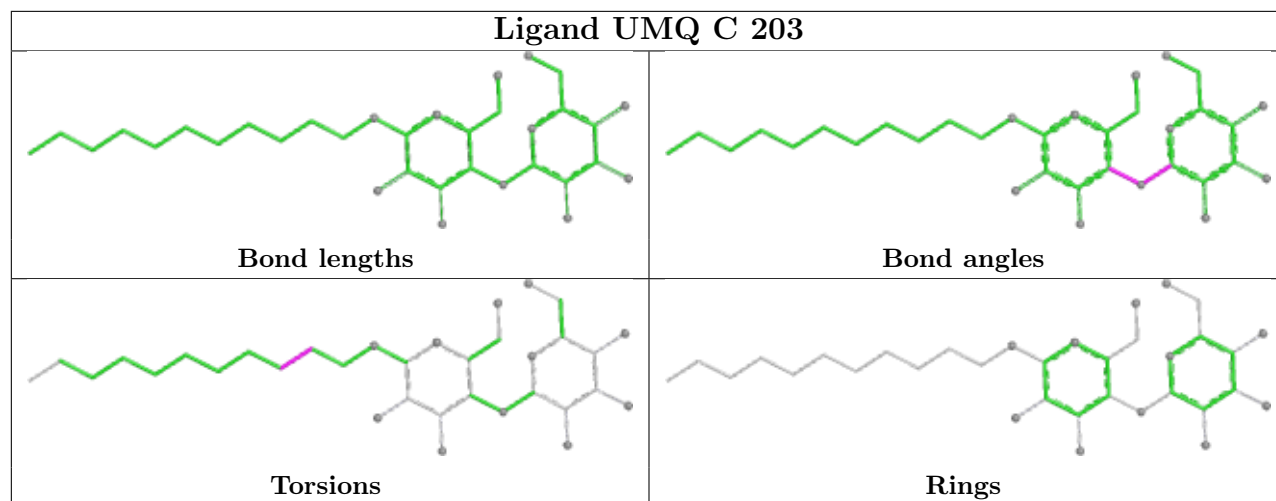
There are no ring outliers.

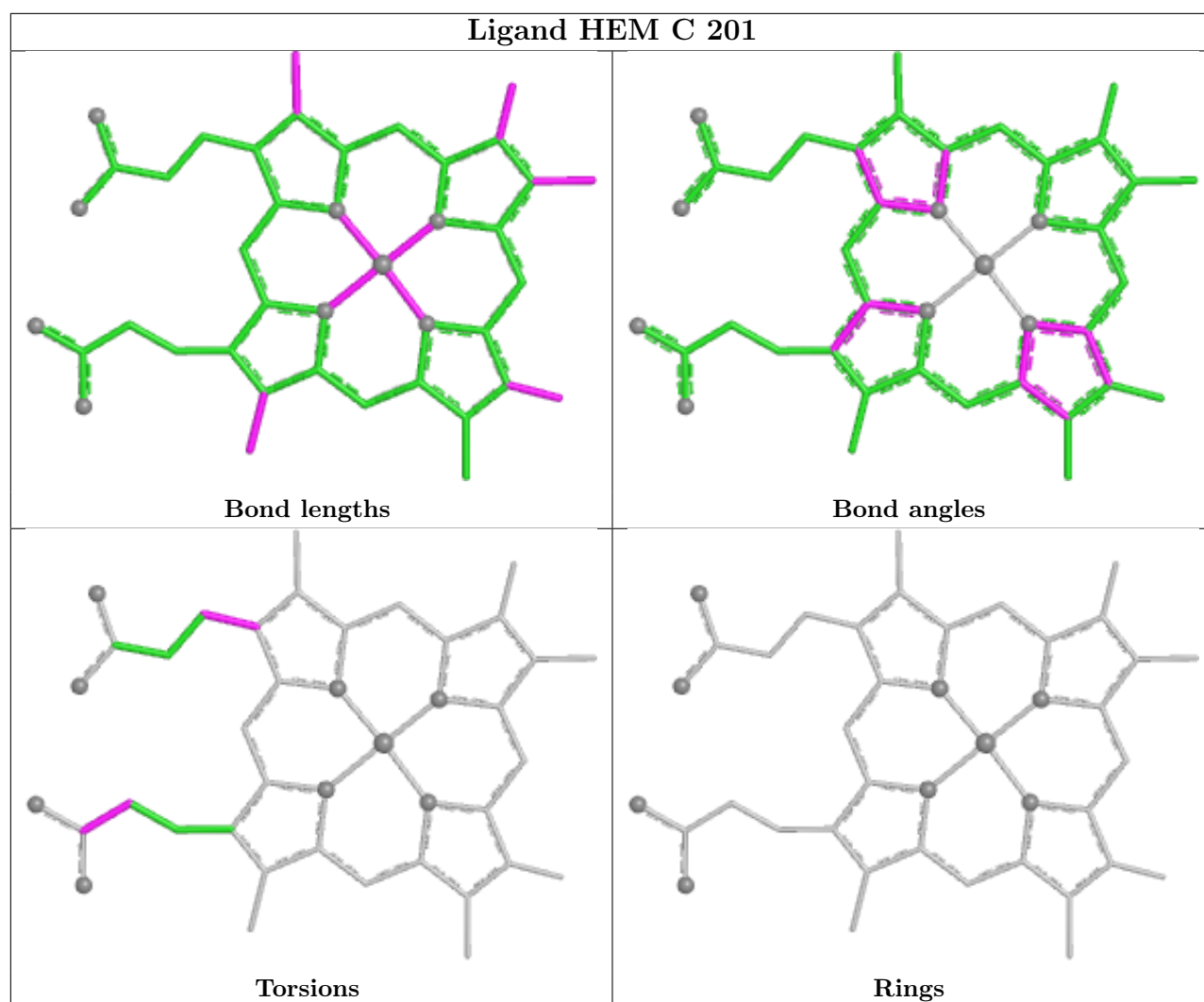
6 monomers are involved in 18 short contacts:

Mol	Chain	Res	Type	Clashes	Symm-Clashes
5	A	1001	FAD	3	0
6	A	1002	OAA	8	0
13	C	202	AT5	3	0
15	C	203	UMQ	1	0
16	D	201	3PE	2	0
14	C	201	HEM	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

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	611/621 (98%)	0.62	23 (3%) 44 46	25, 59, 87, 118	1 (0%)
2	B	240/252 (95%)	0.57	13 (5%) 31 32	38, 50, 91, 112	0
3	C	138/140 (98%)	0.55	6 (4%) 40 41	41, 57, 81, 108	1 (0%)
4	D	102/103 (99%)	0.66	4 (3%) 43 45	40, 56, 77, 100	0
All	All	1091/1116 (97%)	0.60	46 (4%) 40 42	25, 57, 86, 118	2 (0%)

All (46) RSRZ outliers are listed below:

Mol	Chain	Res	Type	RSRZ
4	D	73	TYR	4.5
2	B	47	ALA	3.2
1	A	439	PRO	3.1
1	A	589	VAL	3.1
2	B	245	TYR	2.9
2	B	138	GLY	2.8
2	B	192	ILE	2.8
1	A	315	GLY	2.8
2	B	74	ALA	2.7
1	A	503	LEU	2.6
1	A	358	PRO	2.6
1	A	211	ILE	2.6
4	D	43	LEU	2.6
3	C	27	ILE	2.6
4	D	93	ILE	2.6
1	A	398	ALA	2.5
3	C	126	VAL	2.5
2	B	182	ALA	2.5
2	B	135	SER	2.4
1	A	399	ALA	2.4
1	A	172	TYR	2.3

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Mol	Chain	Res	Type	RSRZ
1	A	401	ALA	2.3
3	C	2	ALA	2.3
1	A	499	ILE	2.3
2	B	169	PRO	2.3
1	A	262	CYS	2.2
1	A	107	VAL	2.2
1	A	317	GLU	2.2
2	B	173	TRP	2.2
1	A	443	PRO	2.2
2	B	180	GLY	2.2
1	A	276	ILE	2.1
1	A	155	HIS	2.1
3	C	87	ALA	2.1
1	A	441	ILE	2.1
1	A	210	VAL	2.1
3	C	73	VAL	2.1
1	A	420	PHE	2.1
2	B	8	THR	2.1
3	C	128	ILE	2.1
4	D	45	LEU	2.1
2	B	167	SER	2.1
1	A	504	ALA	2.0
1	A	385	GLU	2.0
1	A	536	ILE	2.0
2	B	223	ARG	2.0

6.2 Non-standard residues in protein, DNA, RNA chains [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
3	MLZ	C	15	10/11	0.77	0.17	65,69,74,74	0

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
8	UNL	D	205	12/-	0.50	0.23	93,101,105,106	0
8	UNL	C	210	15/-	0.51	0.20	121,125,144,144	0
8	UNL	B	1011	2/-	0.55	0.18	121,121,121,121	0
8	UNL	A	1012	2/-	0.62	0.31	77,77,77,78	0
8	UNL	B	1015	1/-	0.68	0.34	54,54,54,54	0
8	UNL	C	208	5/-	0.69	0.27	82,83,84,84	0
8	UNL	A	1014	6/-	0.74	0.21	99,101,101,102	0
8	UNL	C	209	3/-	0.74	0.23	72,72,74,76	0
8	UNL	B	1005	3/-	0.76	0.15	74,74,76,76	0
8	UNL	A	1018	3/-	0.76	0.21	75,75,75,76	0
8	UNL	B	1013	4/-	0.76	0.14	73,76,76,78	0
8	UNL	D	202	9/-	0.76	0.15	97,102,103,104	0
8	UNL	A	1028	1/-	0.76	0.16	76,76,76,76	0
16	3PE	D	201	42/51	0.76	0.25	71,89,119,122	0
8	UNL	A	1019	3/-	0.78	0.51	50,50,50,55	0
8	UNL	A	1011	4/-	0.79	0.16	123,124,124,125	0
8	UNL	A	1023	1/-	0.81	0.14	48,48,48,48	0
8	UNL	A	1006	7/-	0.81	0.21	80,84,86,87	0
8	UNL	A	1022	1/-	0.81	0.15	59,59,59,59	0
8	UNL	D	206	12/-	0.82	0.19	75,82,87,87	0
8	UNL	B	1007	3/-	0.82	0.23	82,82,84,85	0
8	UNL	C	207	12/-	0.83	0.16	73,87,91,91	0
8	UNL	A	1017	2/-	0.83	0.29	72,72,72,74	0
8	UNL	A	1020	3/-	0.83	0.22	62,62,68,70	0
8	UNL	B	1014	7/-	0.83	0.22	66,71,79,81	0
8	UNL	A	1026	1/-	0.83	0.46	51,51,51,51	0
8	UNL	B	1017	1/-	0.83	0.13	39,39,39,39	1
8	UNL	B	1021	1/-	0.83	0.12	73,73,73,73	0
9	PEG	A	1005	5/7	0.83	0.28	67,72,85,88	0
13	AT5	C	202	23/23	0.83	0.21	49,57,124,129	0
8	UNL	C	204	3/-	0.83	0.37	45,45,48,55	0
8	UNL	C	205	3/-	0.84	0.30	48,48,53,54	0
8	UNL	C	206	15/-	0.84	0.30	54,72,81,81	15
15	UMQ	C	203	34/34	0.84	0.17	54,81,105,109	0
8	UNL	B	1008	3/-	0.84	0.14	53,53,60,63	0
8	UNL	A	1009	4/-	0.85	0.14	77,81,86,88	0
8	UNL	A	1010	4/-	0.85	0.16	60,61,62,69	0

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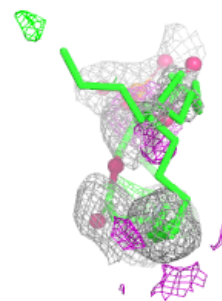
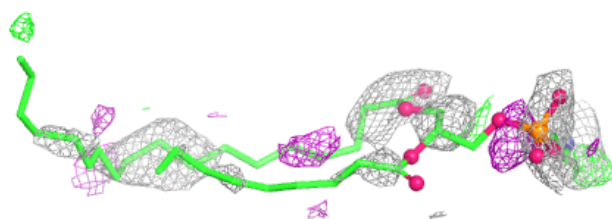
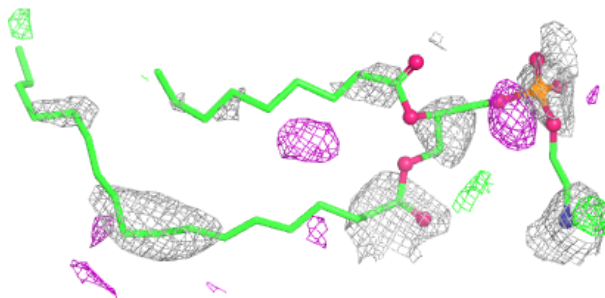
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Mol	Type	Chain	Res	Atoms	RSCC	RSR	B-factors($\text{\AA}^2$)	Q<0.9
8	UNL	D	204	5/-	0.85	0.16	81,81,82,82	0
8	UNL	B	1018	1/-	0.86	0.15	46,46,46,46	0
8	UNL	D	207	10/-	0.86	0.12	58,72,77,79	0
8	UNL	A	1008	4/-	0.86	0.11	70,73,74,76	0
8	UNL	B	1010	4/-	0.87	0.10	70,71,72,73	0
6	OAA	A	1002	9/9	0.87	0.10	55,57,60,63	0
8	UNL	B	1006	3/-	0.88	0.11	71,71,72,72	0
8	UNL	D	208	1/-	0.88	0.13	70,70,70,70	0
8	UNL	B	1004	4/-	0.88	0.15	54,56,58,70	0
8	UNL	A	1015	3/-	0.89	0.17	74,74,76,78	0
8	UNL	B	1012	3/-	0.89	0.14	75,75,75,76	0
8	UNL	D	203	5/-	0.89	0.30	63,64,65,66	5
8	UNL	B	1020	1/-	0.90	0.12	40,40,40,40	0
8	UNL	A	1016	2/-	0.90	0.09	78,78,78,79	0
8	UNL	A	1025	1/-	0.90	0.11	40,40,40,40	1
7	K	A	1003	1/1	0.90	0.08	60,60,60,60	0
8	UNL	B	1009	4/-	0.90	0.09	76,77,77,77	0
8	UNL	B	1019	1/-	0.91	0.12	50,50,50,50	0
8	UNL	A	1007	4/-	0.91	0.11	62,65,66,68	0
8	UNL	A	1013	3/-	0.91	0.22	45,45,47,50	3
8	UNL	A	1021	1/-	0.92	0.05	45,45,45,45	0
8	UNL	B	1016	1/-	0.92	0.14	37,37,37,37	0
8	UNL	C	211	4/-	0.92	0.11	84,86,88,89	0
8	UNL	C	212	1/-	0.92	0.05	55,55,55,55	0
8	UNL	A	1027	1/-	0.92	0.11	55,55,55,55	0
8	UNL	B	1022[A]	1/-	0.93	0.12	41,41,41,41	1
8	UNL	B	1022[B]	1/-	0.93	0.12	42,42,42,42	1
5	FAD	A	1001	53/53	0.94	0.09	39,47,54,55	0
8	UNL	A	1004	5/-	0.94	0.12	78,79,82,84	4
8	UNL	A	1024	1/-	0.95	0.08	46,46,46,46	0
12	F3S	B	1003	7/7	0.96	0.08	37,41,44,44	0
10	FES	B	1001	4/4	0.97	0.05	41,45,45,48	0
14	HEM	C	201	41/43	0.97	0.10	42,50,61,66	0
11	SF4	B	1002	8/8	0.98	0.04	34,41,45,48	0

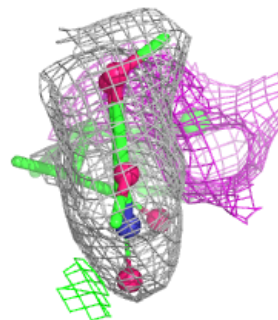
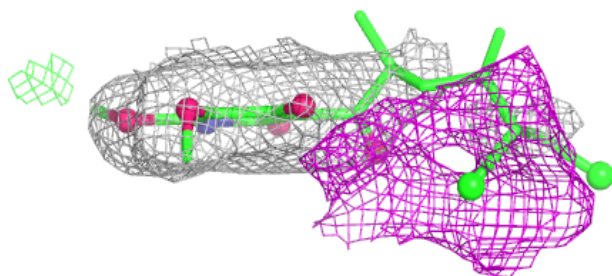
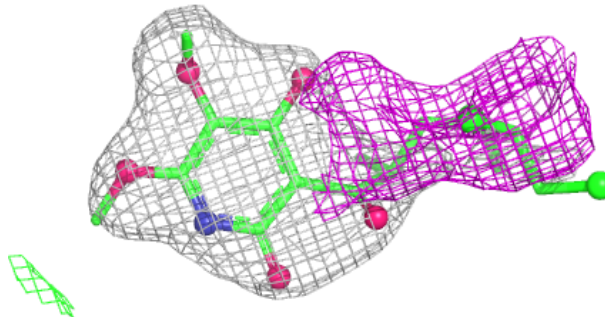
The following is a graphical depiction of the model fit to experimental electron density of all instances of the Ligand of Interest. In addition, ligands with molecular weight > 250 and outliers as shown on the geometry validation Tables will also be included. Each fit is shown from different orientation to approximate a three-dimensional view.

Electron density around 3PE D 201:

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

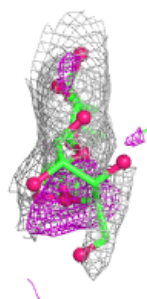
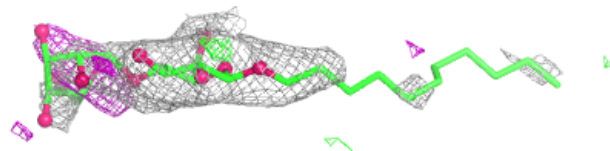
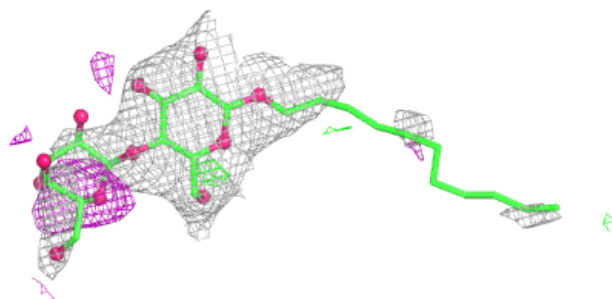
**Electron density around AT5 C 202:**

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

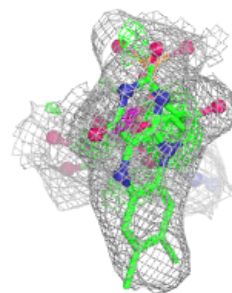
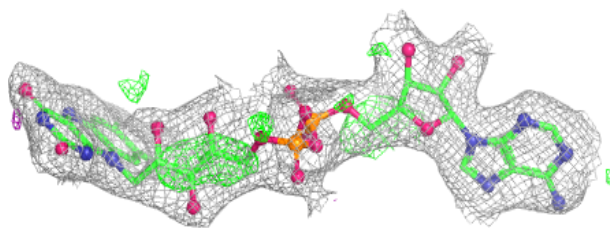
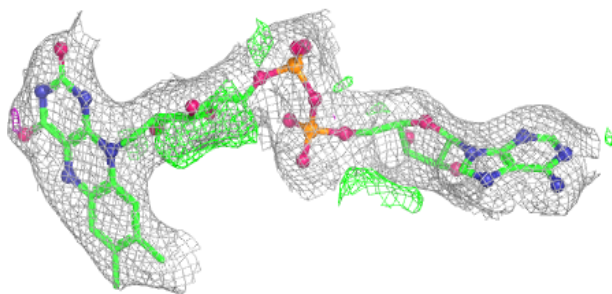


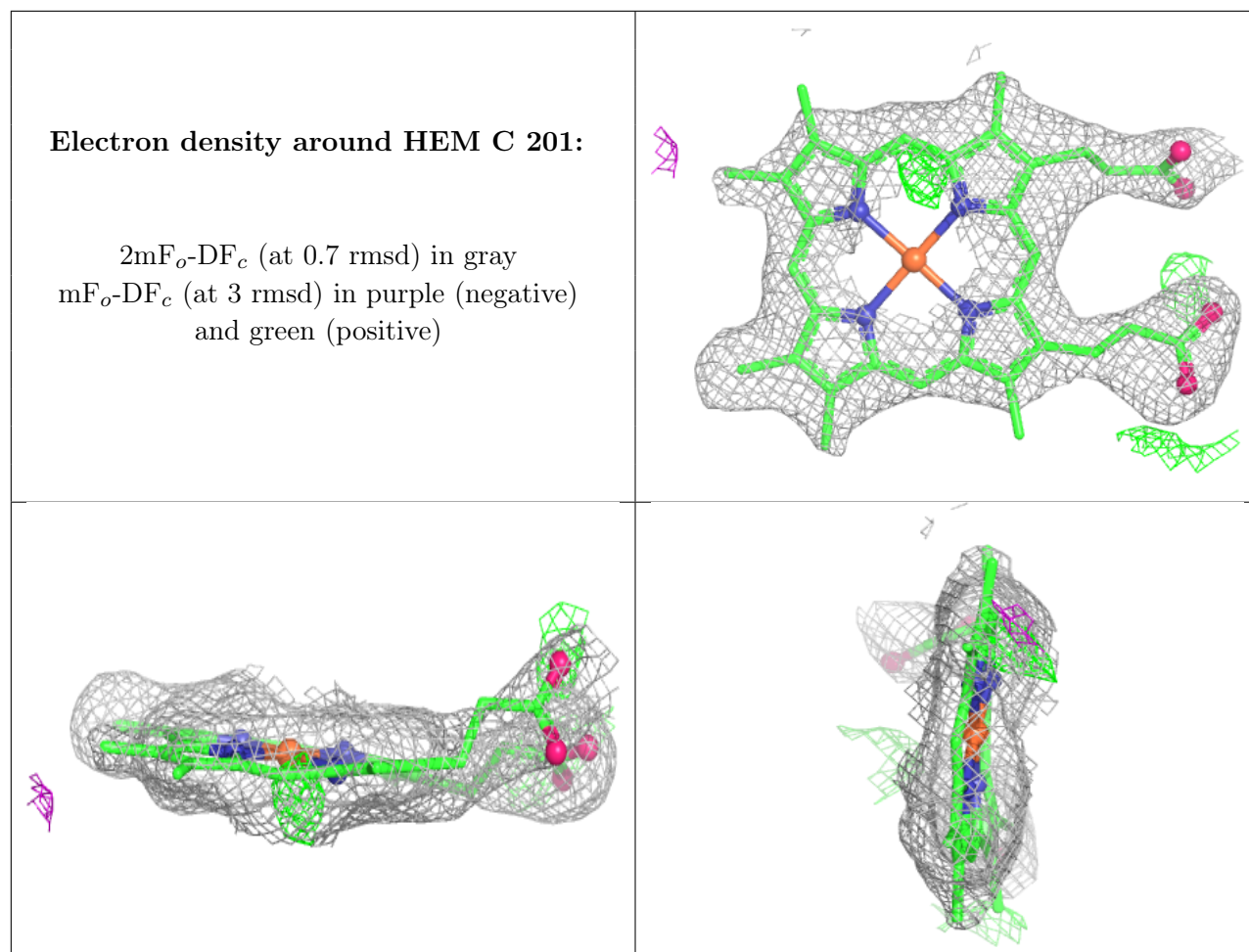
Electron density around UMQ C 203:

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

**Electron density around FAD A 1001:**

$2mF_o-DF_c$ (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.