



wwPDB X-ray Structure Validation Summary Report ⓘ

Mar 5, 2026 – 07:56 PM UTC

PDB ID : 2XQ1 / pdb_00002xq1
Title : Crystal structure of peroxisomal catalase from the yeast *Hansenula polymorpha*
Authors : Penya-Soler, E.; Vega, M.C.; Wilmanns, M.; Williams, C.P.
Deposited on : 2010-08-31
Resolution : 2.90 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

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

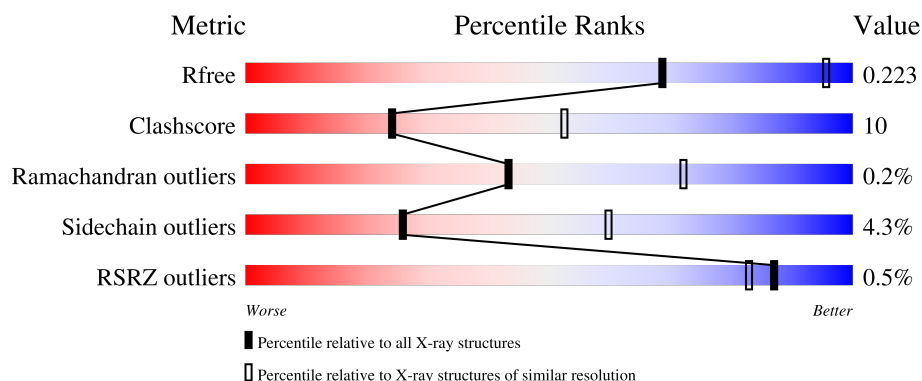
1 Overall quality at a glance

The following experimental techniques were used to determine the structure:

X-RAY DIFFRACTION

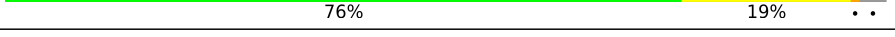
The reported resolution of this entry is 2.90 Å.

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	2481 (2.90-2.90)
Clashscore	190562	2690 (2.90-2.90)
Ramachandran outliers	187476	2623 (2.90-2.90)
Sidechain outliers	187428	2625 (2.90-2.90)
RSRZ outliers	180081	2481 (2.90-2.90)

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	509	 74% 21% . .
1	B	509	 75% 20% . .
1	C	509	 74% 22% . .
1	D	509	 76% 19% . .
1	E	509	 70% 24% . .

Continued on next page...

Continued from previous page...

Mol	Chain	Length	Quality of chain
1	F	509	2% 72% 24% ..
1	G	509	72% 23% ..
1	H	509	74% 21% ..
1	I	509	% 73% 22% ..
1	J	509	% 71% 25% ..
1	K	509	% 75% 20% ..
1	L	509	73% 21% ..
1	M	509	73% 22% ..
1	N	509	71% 24% ..
1	O	509	79% 17% ..
1	P	509	% 73% 21% ..

2 Entry composition

There are 3 unique types of molecules in this entry. The entry contains 63839 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.

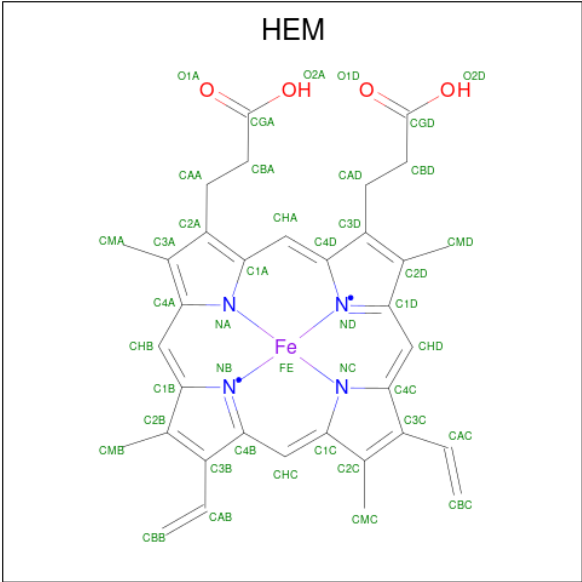
- Molecule 1 is a protein called PEROXISOMAL CATALASE.

Mol	Chain	Residues	Atoms					ZeroOcc	AltConf	Trace
1	A	491	Total	C	N	O	S	0	0	0
			3925	2517	664	731	13			
1	B	494	Total	C	N	O	S	0	0	0
			3953	2532	671	737	13			
1	C	492	Total	C	N	O	S	0	0	0
			3960	2536	672	739	13			
1	D	494	Total	C	N	O	S	0	0	0
			3959	2534	673	739	13			
1	E	490	Total	C	N	O	S	0	0	0
			3947	2527	670	737	13			
1	F	494	Total	C	N	O	S	0	0	0
			3950	2529	671	737	13			
1	G	491	Total	C	N	O	S	0	0	0
			3951	2531	671	736	13			
1	H	487	Total	C	N	O	S	0	0	0
			3922	2511	666	732	13			
1	I	491	Total	C	N	O	S	0	0	0
			3959	2534	672	740	13			
1	J	491	Total	C	N	O	S	0	0	0
			3943	2525	670	735	13			
1	K	490	Total	C	N	O	S	0	0	0
			3949	2529	670	737	13			
1	L	489	Total	C	N	O	S	0	0	0
			3933	2519	669	732	13			
1	M	491	Total	C	N	O	S	0	0	0
			3945	2526	671	735	13			
1	N	491	Total	C	N	O	S	0	0	0
			3945	2522	669	741	13			
1	O	493	Total	C	N	O	S	0	0	0
			3957	2534	673	737	13			
1	P	491	Total	C	N	O	S	0	0	0
			3931	2518	668	732	13			

There are 32 discrepancies between the modelled and reference sequences:

Chain	Residue	Modelled	Actual	Comment	Reference
A	-1	GLY	-	expression tag	UNP P30263
A	0	ALA	-	expression tag	UNP P30263
B	-1	GLY	-	expression tag	UNP P30263
B	0	ALA	-	expression tag	UNP P30263
C	-1	GLY	-	expression tag	UNP P30263
C	0	ALA	-	expression tag	UNP P30263
D	-1	GLY	-	expression tag	UNP P30263
D	0	ALA	-	expression tag	UNP P30263
E	-1	GLY	-	expression tag	UNP P30263
E	0	ALA	-	expression tag	UNP P30263
F	-1	GLY	-	expression tag	UNP P30263
F	0	ALA	-	expression tag	UNP P30263
G	-1	GLY	-	expression tag	UNP P30263
G	0	ALA	-	expression tag	UNP P30263
H	-1	GLY	-	expression tag	UNP P30263
H	0	ALA	-	expression tag	UNP P30263
I	-1	GLY	-	expression tag	UNP P30263
I	0	ALA	-	expression tag	UNP P30263
J	-1	GLY	-	expression tag	UNP P30263
J	0	ALA	-	expression tag	UNP P30263
K	-1	GLY	-	expression tag	UNP P30263
K	0	ALA	-	expression tag	UNP P30263
L	-1	GLY	-	expression tag	UNP P30263
L	0	ALA	-	expression tag	UNP P30263
M	-1	GLY	-	expression tag	UNP P30263
M	0	ALA	-	expression tag	UNP P30263
N	-1	GLY	-	expression tag	UNP P30263
N	0	ALA	-	expression tag	UNP P30263
O	-1	GLY	-	expression tag	UNP P30263
O	0	ALA	-	expression tag	UNP P30263
P	-1	GLY	-	expression tag	UNP P30263
P	0	ALA	-	expression tag	UNP P30263

- Molecule 2 is PROTOPORPHYRIN IX CONTAINING FE (CCD ID: HEM) (formula: $C_{34}H_{32}FeN_4O_4$).



Mol	Chain	Residues	Atoms					ZeroOcc	AltConf
2	B	1	Total 43	C 34	Fe 1	N 4	O 4	0	0
2	C	1	Total 43	C 34	Fe 1	N 4	O 4	0	0
2	D	1	Total 43	C 34	Fe 1	N 4	O 4	0	0
2	E	1	Total 43	C 34	Fe 1	N 4	O 4	0	0
2	F	1	Total 43	C 34	Fe 1	N 4	O 4	0	0
2	G	1	Total 43	C 34	Fe 1	N 4	O 4	0	0
2	H	1	Total 43	C 34	Fe 1	N 4	O 4	0	0
2	I	1	Total 43	C 34	Fe 1	N 4	O 4	0	0
2	J	1	Total 43	C 34	Fe 1	N 4	O 4	0	0
2	K	1	Total 43	C 34	Fe 1	N 4	O 4	0	0
2	L	1	Total 43	C 34	Fe 1	N 4	O 4	0	0
2	M	1	Total 43	C 34	Fe 1	N 4	O 4	0	0
2	N	1	Total 43	C 34	Fe 1	N 4	O 4	0	0
2	O	1	Total 43	C 34	Fe 1	N 4	O 4	0	0

Continued on next page...

Continued from previous page...

Mol	Chain	Residues	Atoms				ZeroOcc	AltConf	
2	P	1	Total 43	C 34	Fe 1	N 4	O 4	0	0

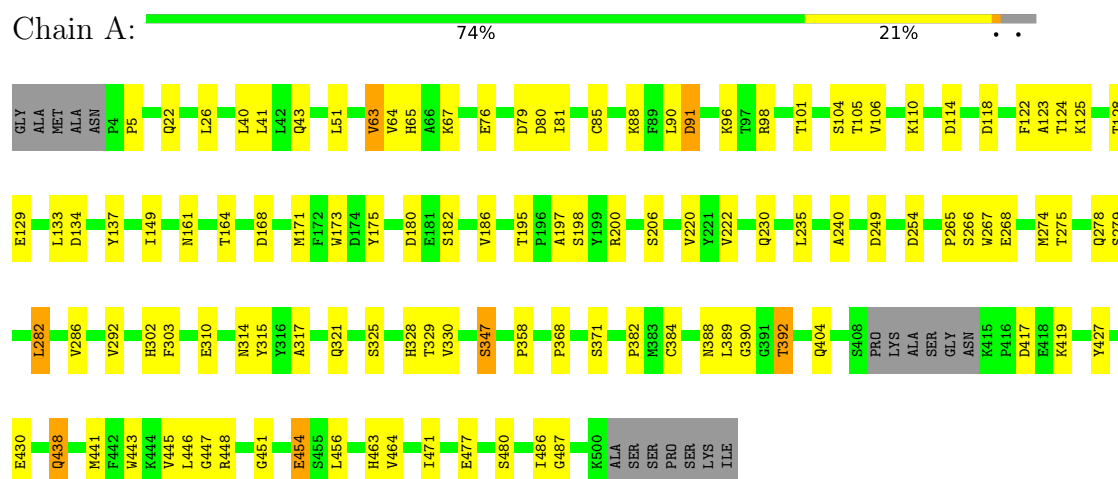
- Molecule 3 is water.

Mol	Chain	Residues	Atoms		ZeroOcc	AltConf
3	A	5	Total 5	O 5	0	0
3	B	7	Total 7	O 7	0	0
3	C	4	Total 4	O 4	0	0
3	D	6	Total 6	O 6	0	0
3	E	3	Total 3	O 3	0	0
3	F	6	Total 6	O 6	0	0
3	G	3	Total 3	O 3	0	0
3	H	2	Total 2	O 2	0	0
3	I	4	Total 4	O 4	0	0
3	J	6	Total 6	O 6	0	0
3	K	1	Total 1	O 1	0	0
3	L	6	Total 6	O 6	0	0
3	M	2	Total 2	O 2	0	0
3	N	1	Total 1	O 1	0	0
3	O	6	Total 6	O 6	0	0
3	P	3	Total 3	O 3	0	0

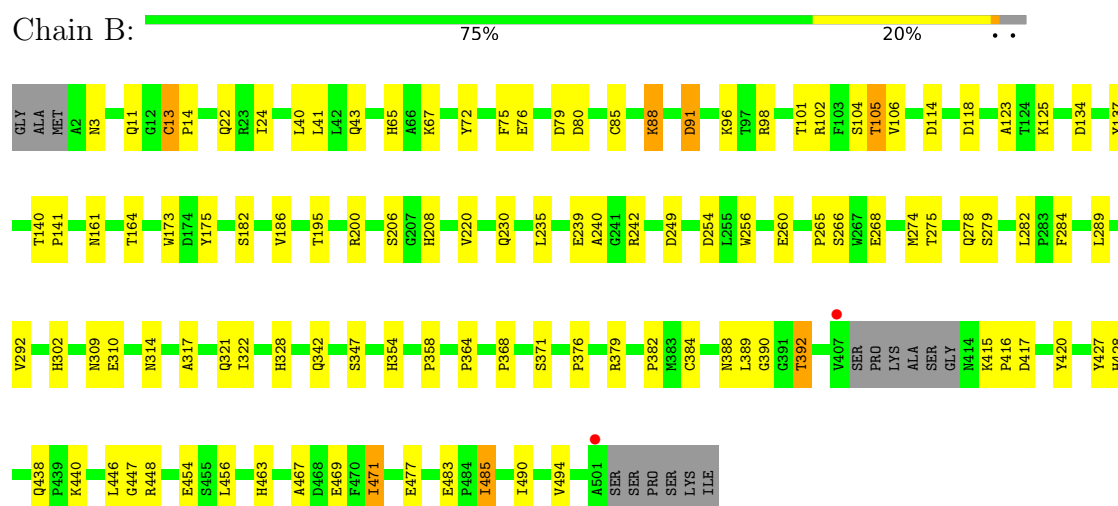
3 Residue-property plots

These plots are drawn for all protein, RNA, DNA and oligosaccharide chains in the entry. The first graphic for a chain summarises the proportions of the various outlier classes displayed in the second graphic. The second graphic shows the sequence view annotated by issues in geometry and electron density. Residues are color-coded according to the number of geometric quality criteria for which they contain at least one outlier: green = 0, yellow = 1, orange = 2 and red = 3 or more. A red dot above a residue indicates a poor fit to the electron density ($RSRZ > 2$). Stretches of 2 or more consecutive residues without any outlier are shown as a green connector. Residues present in the sample, but not in the model, are shown in grey.

• Molecule 1: PEROXISOMAL CATALASE

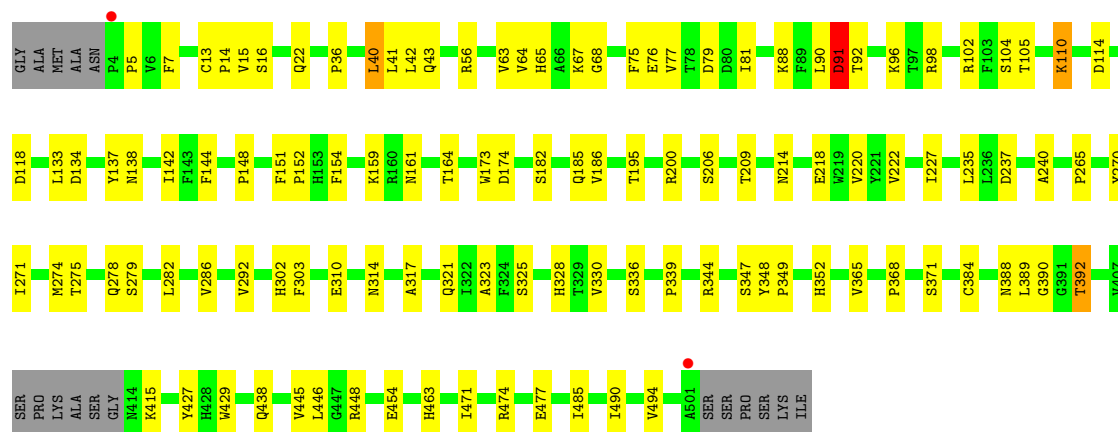


• Molecule 1: PEROXISOMAL CATALASE



• Molecule 1: PEROXISOMAL CATALASE





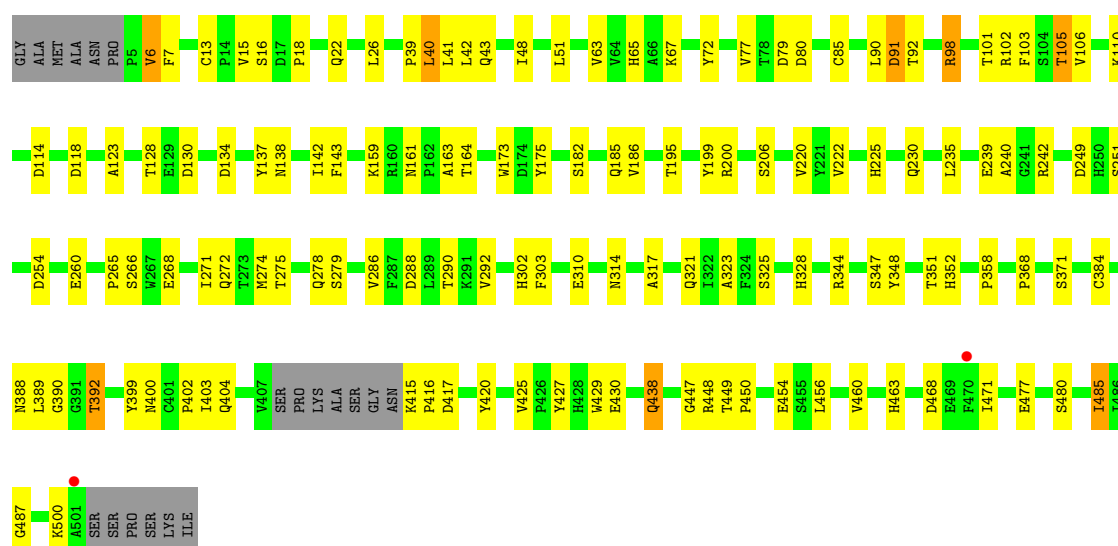
• Molecule 1: PEROXISOMAL CATALASE

Chain D: 76% 19%



• Molecule 1: PEROXISOMAL CATALASE

Chain E: 70% 24%



Chain F:

2% 72% 24%

GLY ALA MET A2 F7 C13 T21 Q22 L40 Q43 K46 L47 R56 E61 R62 V63 H65 A66 K67 Y72 E76 D79 D80 K88 D91 T92 K95 K96 T97 R98 R102 T105 K110 D114 D118 D130 D134 Y137 N138 I142 F143 F144 P148 H153 F154 M161 T164 D168 M171 F172 D173 D174 Y175 L176 T177 S182 Q185 V186 T195 R200 Y205 S206 G207 H208 N214 E218 W219 V220 Y221 V222 Q230 L235 E239 A240 G241 R242 D254 L255 H256 L389 P285 S286 Y270 M274 T275 Q278 S279 L282 P283 F284 L289 V292 W293 P294 L300 R301 H302 E310 N314 A317 E318 Q321 S325 H328 P339 Q342 S343 R344 S347 Y348 T351 P368 L369 K370 S371 G372 S373 C394 L497 K498 R499 L500 A501 SER PRO SER LYS ILE

Chain G: 72% 23%

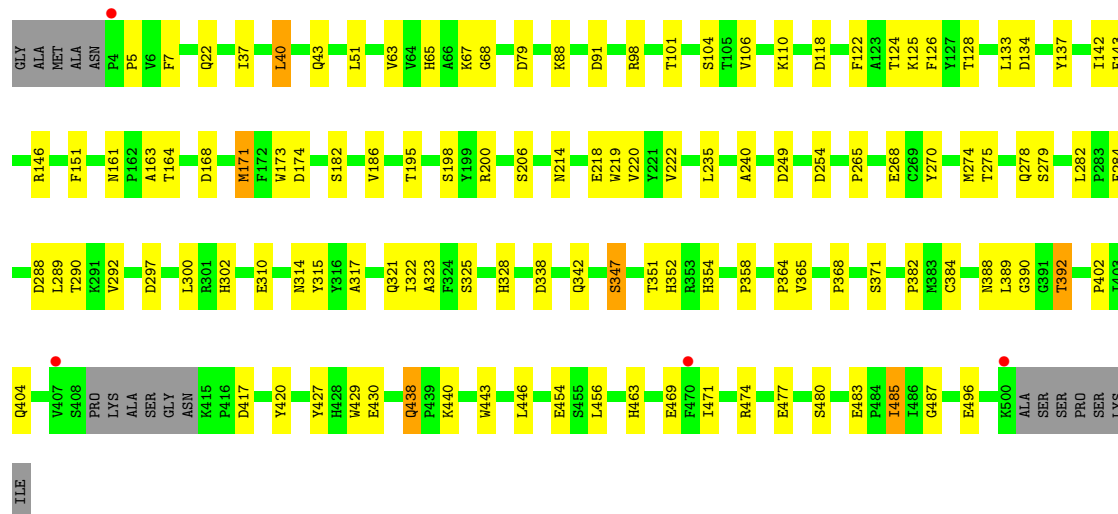
ASN	GLY	ALA	MET	ALA	ASN	P4	F7	C13	P14	V15	P18	Q22	K32	P36	P39	L40	L41	L42	Q43	K45	T50	I59	V63	V64	H65	Y72	K88	D91	T92	R98	T101	R102	F103	S104	T105	V106	A123	L133	D134	Q278	Y137	V139
P283	I149	K150	F151	P152	H153	F154	T157	M161	T164	M171	F172	W173	D174	Y175	S182	L183	V186	T195	R200	Y205	S206	V220	Y221	Y222	Q230	L235	L236	D237	A240	W256	E260	P265	S266	Q267	E268	M274	T275	Q278	Y137	V139		
H302	E310	N314	A317	Q321	T322	A323	F324	S325	H328	T329	V330	S347	H352	F353	H354	V365	P368	S371	I377	C394	N388	L389	G390	T392	C401	P402	I403	Q404	Y405	A406	V407	SER	PRO	LYS	ALA	SER	CYS					
V425	Y427	H428	W429	Q438	L446	G447	R448	G451	E454	S455	L456	H463	V464	A467	I471	R474	V475	Y476	E477	S480	K481	A482	G487	D488	L489	I490	K492	K493	V494	A501	SER	SER	PRO	SER	LYS	ILE						

Chain H:

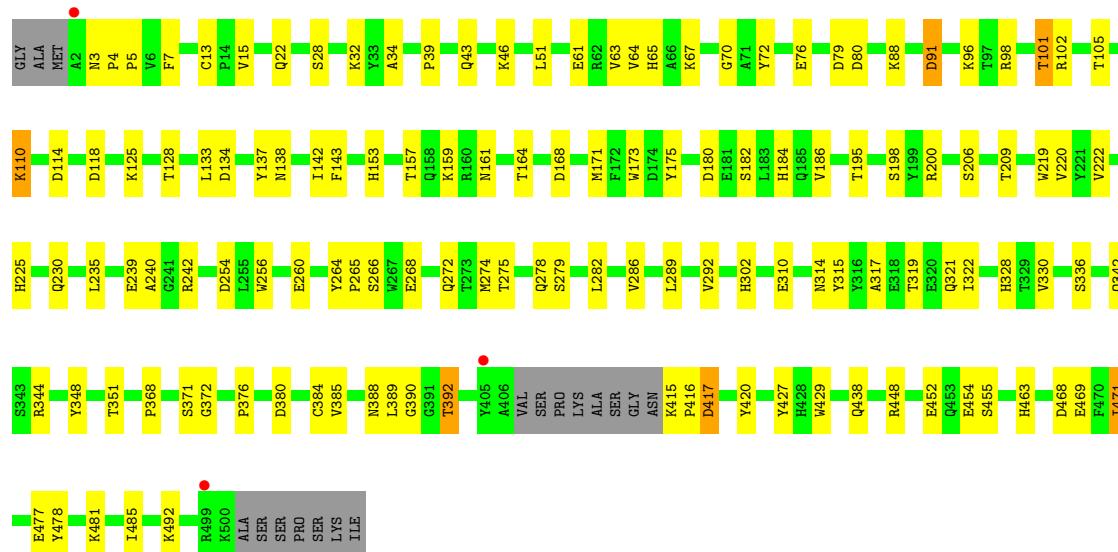
GLY	ALA	MET	ALA	ASN	PRO	PRO	V6	C13	S16	D17	P18	Q22	R23	I24	S28	A34	G38	F39	L40	Q43	D44	F45	K46	V63	V64	H65	A66	K67	D79	D80	C85	D91	T92	E98	R102	F103	S104	T105	V106	D114	R117	D118	T108
E129	D130	D134	Y137	I142	P148	T157	M161	T164	W173	D174	Y175	D180	L183	H184	Q185	T195	R200	T201	S206	G207	H208	N214	E218	W219	V220	V221	V222	H233	N234	L235	D237	E238	A240	G241	R242	D249	E260	P265					



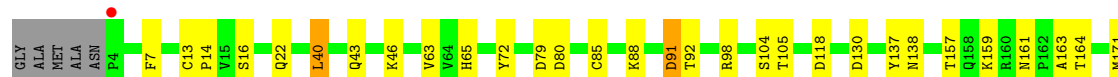
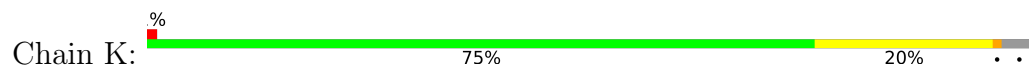
• Molecule 1: PEROXISOMAL CATALASE

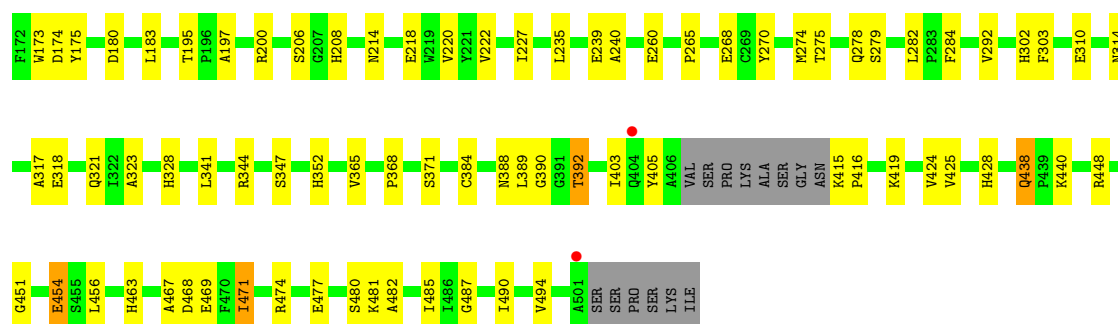


• Molecule 1: PEROXISOMAL CATALASE

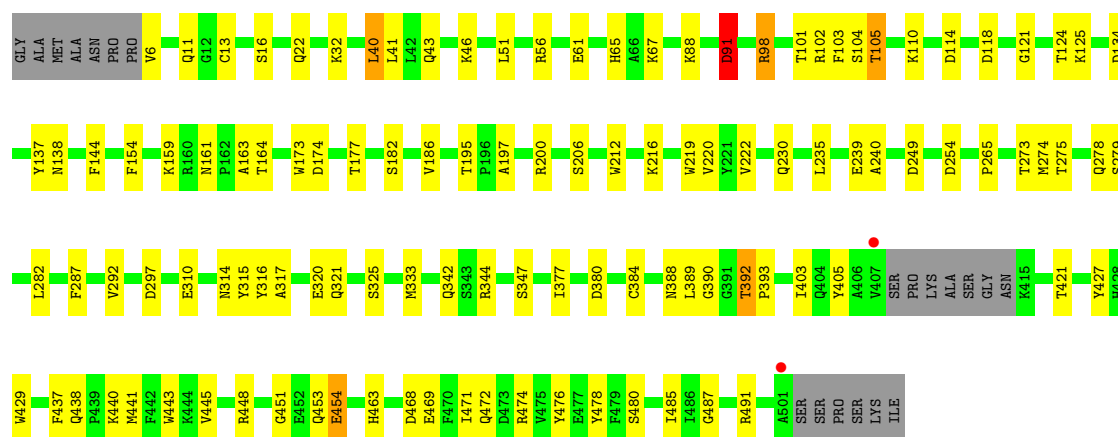


• Molecule 1: PEROXISOMAL CATALASE

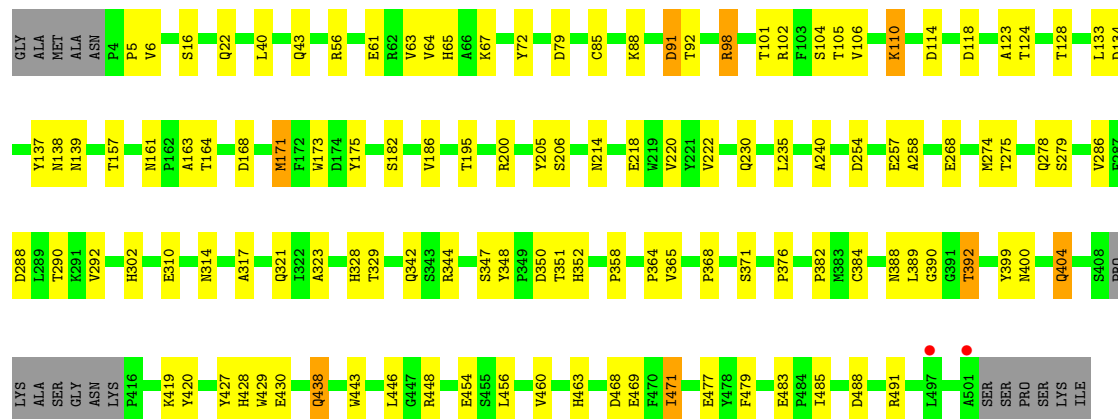




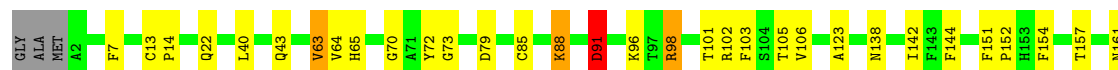
- Molecule 1: PEROXISOMAL CATALASE

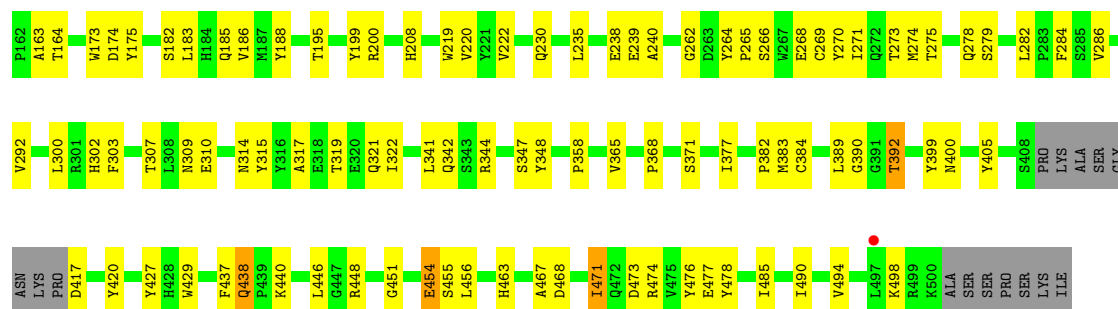


- Molecule 1: PEROXISOMAL CATALASE



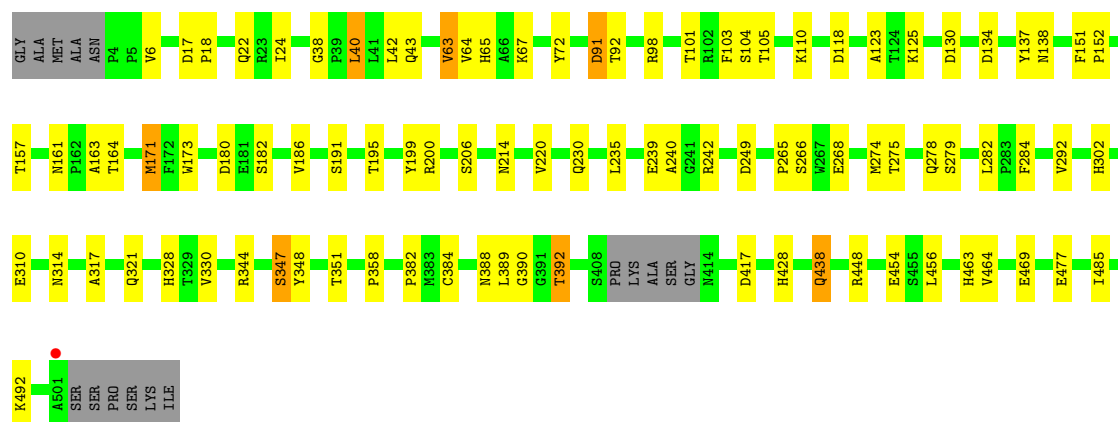
- Molecule 1: PEROXISOMAL CATALASE





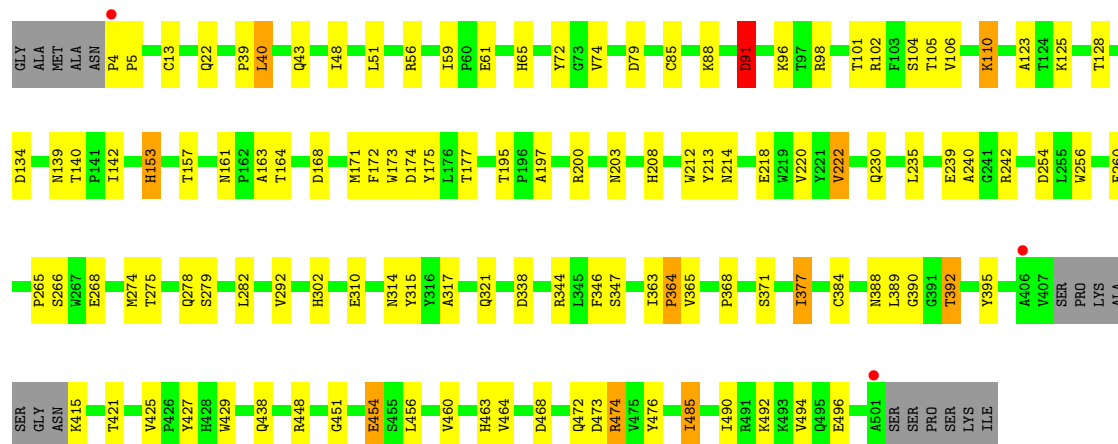
• Molecule 1: PEROXISOMAL CATALASE

Chain O: 79% 17% . .



• Molecule 1: PEROXISOMAL CATALASE

Chain P: 73% 21% . .



4 Data and refinement statistics

Property	Value	Source
Space group	P 1 21 1	Depositor
Cell constants a, b, c, α , β , γ	132.52Å 196.68Å 170.85Å 90.00° 92.85° 90.00°	Depositor
Resolution (Å)	20.00 – 2.90 20.00 – 2.90	Depositor EDS
% Data completeness (in resolution range)	100.0 (20.00-2.90) 99.7 (20.00-2.90)	Depositor EDS
R_{merge}	0.12	Depositor
R_{sym}	(Not available)	Depositor
$\langle I/\sigma(I) \rangle$ ¹	2.16 (at 2.88Å)	Xtriage
Refinement program	REFMAC 5.5.0109	Depositor
R, R_{free}	0.191 , 0.223 0.193 , 0.223	Depositor DCC
R_{free} test set	976 reflections (0.51%)	wwPDB-VP
Wilson B-factor (Å ²)	47.6	Xtriage
Anisotropy	0.050	Xtriage
Bulk solvent k_{sol} (e/Å ³), B_{sol} (Å ²)	0.29 , 22.8	EDS
L-test for twinning ²	$\langle L \rangle = 0.48$, $\langle L^2 \rangle = 0.31$	Xtriage
Estimated twinning fraction	0.018 for h,-k,-l	Xtriage
F_o, F_c correlation	0.93	EDS
Total number of atoms	63839	wwPDB-VP
Average B, all atoms (Å ²)	42.0	wwPDB-VP

Xtriage'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.*

¹Intensities estimated from amplitudes.

²Theoretical values of $\langle |L| \rangle$, $\langle L^2 \rangle$ for acentric reflections are 0.5, 0.333 respectively for untwinned datasets, and 0.375, 0.2 for perfectly twinned datasets.

5 Model quality

5.1 Standard geometry

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

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	0.84	0/4052	1.03	9/5523 (0.2%)
1	B	0.84	0/4080	1.02	10/5562 (0.2%)
1	C	0.85	0/4087	0.99	9/5566 (0.2%)
1	D	0.82	0/4086	1.05	13/5568 (0.2%)
1	E	0.84	1/4073 (0.0%)	1.02	9/5545 (0.2%)
1	F	0.85	0/4077	0.99	7/5557 (0.1%)
1	G	0.87	2/4078 (0.0%)	1.03	11/5553 (0.2%)
1	H	0.85	0/4047	1.02	6/5511 (0.1%)
1	I	0.85	0/4086	1.03	8/5563 (0.1%)
1	J	0.85	0/4070	1.04	5/5545 (0.1%)
1	K	0.81	1/4076 (0.0%)	0.98	7/5550 (0.1%)
1	L	0.84	0/4058	1.02	7/5525 (0.1%)
1	M	0.79	0/4072	0.98	6/5545 (0.1%)
1	N	0.82	0/4071	1.00	3/5547 (0.1%)
1	O	0.79	0/4084	0.99	6/5562 (0.1%)
1	P	0.81	0/4058	0.99	6/5529 (0.1%)
All	All	0.83	4/65155 (0.0%)	1.01	122/88751 (0.1%)

Chiral center outliers are detected by calculating the chiral volume of a chiral center and verifying if the center is modelled as a planar moiety or with the opposite hand. A planarity outlier is detected by checking planarity of atoms in a peptide group, atoms in a mainchain group or atoms of a sidechain that are expected to be planar.

Mol	Chain	#Chirality outliers	#Planarity outliers
1	A	0	1
1	B	0	1
1	E	0	1
1	F	0	1
1	G	0	1
All	All	0	5

All (4) bond length outliers are listed below:

Mol	Chain	Res	Type	Atoms	Z	Observed(Å)	Ideal(Å)
1	G	491	ARG	CZ-NH1	9.57	1.46	1.32
1	G	491	ARG	CD-NE	6.39	1.55	1.46
1	K	403	ILE	CA-CB	6.25	1.62	1.54
1	E	242	ARG	CZ-NH1	5.56	1.40	1.32

The worst 5 of 122 bond angle outliers are listed below:

Mol	Chain	Res	Type	Atoms	Z	Observed(°)	Ideal(°)
1	G	491	ARG	NE-CZ-NH2	11.79	129.82	119.20
1	G	491	ARG	NH1-CZ-NH2	-8.24	108.59	119.30
1	A	448	ARG	N-CA-C	-7.88	103.39	113.16
1	B	13	CYS	CA-C-N	7.51	127.50	119.76
1	B	13	CYS	C-N-CA	7.51	127.50	119.76

There are no chirality outliers.

All (5) planarity outliers are listed below:

Mol	Chain	Res	Type	Group
1	A	447	GLY	Peptide
1	B	447	GLY	Peptide
1	E	447	GLY	Peptide
1	F	447	GLY	Peptide
1	G	491	ARG	Sidechain

5.2 Too-close contacts

In the following table, the Non-H and H(model) columns list the number of non-hydrogen atoms and hydrogen atoms in the chain respectively. The H(added) column lists the number of hydrogen atoms added and optimized by MolProbity. The Clashes column lists the number of clashes within the asymmetric unit, whereas Symm-Clashes lists symmetry-related clashes.

Mol	Chain	Non-H	H(model)	H(added)	Clashes	Symm-Clashes
1	A	3925	0	3662	80	0
1	B	3953	0	3696	75	0
1	C	3960	0	3734	84	0
1	D	3959	0	3716	80	0
1	E	3947	0	3720	100	0
1	F	3950	0	3693	95	0
1	G	3951	0	3725	90	0
1	H	3922	0	3690	72	0

Continued on next page...

Continued from previous page...

Mol	Chain	Non-H	H(model)	H(added)	Clashes	Symm-Clashes
1	I	3959	0	3735	85	0
1	J	3943	0	3703	92	0
1	K	3949	0	3725	78	0
1	L	3933	0	3706	83	0
1	M	3945	0	3719	88	0
1	N	3945	0	3691	95	0
1	O	3957	0	3726	65	0
1	P	3931	0	3687	91	0
2	B	43	0	30	6	0
2	C	43	0	30	6	0
2	D	43	0	30	4	0
2	E	43	0	30	5	0
2	F	43	0	30	3	0
2	G	43	0	30	3	0
2	H	43	0	30	5	0
2	I	43	0	30	1	0
2	J	43	0	30	6	0
2	K	43	0	30	7	0
2	L	43	0	30	6	0
2	M	43	0	30	3	0
2	N	43	0	30	5	0
2	O	43	0	30	5	0
2	P	43	0	30	3	0
3	A	5	0	0	0	0
3	B	7	0	0	2	0
3	C	4	0	0	1	0
3	D	6	0	0	0	0
3	E	3	0	0	0	0
3	F	6	0	0	0	0
3	G	3	0	0	0	0
3	H	2	0	0	0	0
3	I	4	0	0	1	0
3	J	6	0	0	3	0
3	K	1	0	0	1	0
3	L	6	0	0	0	0
3	M	2	0	0	0	0
3	N	1	0	0	0	0
3	O	6	0	0	0	0
3	P	3	0	0	1	0
All	All	63839	0	59778	1235	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 10.

The worst 5 of 1235 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:M:292:VAL:H	1:M:438:GLN:HE22	1.07	1.02
1:H:292:VAL:H	1:H:438:GLN:HE22	1.11	0.95
1:D:274:MET:CE	1:D:279:SER:HA	1.96	0.95
1:H:314:ASN:HD22	1:H:317:ALA:H	1.15	0.94
1:L:292:VAL:H	1:L:438:GLN:HE22	1.07	0.94

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	487/509 (96%)	464 (95%)	21 (4%)	2 (0%)	30	59
1	B	490/509 (96%)	471 (96%)	19 (4%)	0	100	100
1	C	488/509 (96%)	464 (95%)	22 (4%)	2 (0%)	30	59
1	D	490/509 (96%)	473 (96%)	17 (4%)	0	100	100
1	E	486/509 (96%)	463 (95%)	21 (4%)	2 (0%)	30	59
1	F	490/509 (96%)	467 (95%)	23 (5%)	0	100	100
1	G	487/509 (96%)	468 (96%)	19 (4%)	0	100	100
1	H	483/509 (95%)	456 (94%)	25 (5%)	2 (0%)	30	59
1	I	487/509 (96%)	467 (96%)	18 (4%)	2 (0%)	30	59
1	J	487/509 (96%)	466 (96%)	18 (4%)	3 (1%)	21	51
1	K	486/509 (96%)	462 (95%)	23 (5%)	1 (0%)	43	72
1	L	485/509 (95%)	464 (96%)	20 (4%)	1 (0%)	43	72
1	M	487/509 (96%)	458 (94%)	28 (6%)	1 (0%)	43	72
1	N	487/509 (96%)	466 (96%)	20 (4%)	1 (0%)	43	72

Continued on next page...

Continued from previous page...

Mol	Chain	Analysed	Favoured	Allowed	Outliers	Percentiles
1	O	489/509 (96%)	464 (95%)	24 (5%)	1 (0%)	43 72
1	P	487/509 (96%)	473 (97%)	13 (3%)	1 (0%)	43 72
All	All	7796/8144 (96%)	7446 (96%)	331 (4%)	19 (0%)	43 72

5 of 19 Ramachandran outliers are listed below:

Mol	Chain	Res	Type
1	A	180	ASP
1	J	91	ASP
1	N	91	ASP
1	P	91	ASP
1	E	91	ASP

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	412/447 (92%)	395 (96%)	17 (4%)	27 61
1	B	417/447 (93%)	399 (96%)	18 (4%)	26 60
1	C	424/447 (95%)	410 (97%)	14 (3%)	33 67
1	D	421/447 (94%)	406 (96%)	15 (4%)	31 65
1	E	422/447 (94%)	405 (96%)	17 (4%)	28 62
1	F	417/447 (93%)	400 (96%)	17 (4%)	27 61
1	G	422/447 (94%)	399 (94%)	23 (6%)	19 50
1	H	419/447 (94%)	398 (95%)	21 (5%)	22 53
1	I	425/447 (95%)	404 (95%)	21 (5%)	22 54
1	J	419/447 (94%)	399 (95%)	20 (5%)	23 55
1	K	423/447 (95%)	405 (96%)	18 (4%)	26 60
1	L	419/447 (94%)	404 (96%)	15 (4%)	31 65
1	M	422/447 (94%)	400 (95%)	22 (5%)	21 52
1	N	420/447 (94%)	404 (96%)	16 (4%)	29 64

Continued on next page...

Continued from previous page...

Mol	Chain	Analysed	Rotameric	Outliers	Percentiles	
1	O	422/447 (94%)	404 (96%)	18 (4%)	26	60
1	P	417/447 (93%)	399 (96%)	18 (4%)	26	60
All	All	6721/7152 (94%)	6431 (96%)	290 (4%)	26	60

5 of 290 residues with a non-rotameric sidechain are listed below:

Mol	Chain	Res	Type
1	M	428	HIS
1	P	454	GLU
1	N	40	LEU
1	O	220	VAL
1	F	485	ILE

Sometimes sidechains can be flipped to improve hydrogen bonding and reduce clashes. 5 of 233 such sidechains are listed below:

Mol	Chain	Res	Type
1	H	438	GLN
1	P	158	GLN
1	J	438	GLN
1	P	22	GLN
1	N	328	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 oligosaccharides in this entry.

5.6 Ligand geometry [i](#)

15 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$
2	HEM	B	1503	1	50,50,50	1.99	10 (20%)	67,82,82	1.60	8 (11%)
2	HEM	O	1503	1	50,50,50	1.92	8 (16%)	67,82,82	1.54	13 (19%)
2	HEM	D	1503	1	50,50,50	2.03	9 (18%)	67,82,82	1.79	18 (26%)
2	HEM	P	1503	1	50,50,50	1.88	10 (20%)	67,82,82	1.51	9 (13%)
2	HEM	I	1503	1	50,50,50	1.95	7 (14%)	67,82,82	1.56	9 (13%)
2	HEM	H	1503	1	50,50,50	2.07	10 (20%)	67,82,82	1.57	11 (16%)
2	HEM	J	1503	1	50,50,50	2.06	9 (18%)	67,82,82	1.44	7 (10%)
2	HEM	E	1503	1	50,50,50	1.93	10 (20%)	67,82,82	1.71	14 (20%)
2	HEM	K	1503	1	50,50,50	1.92	8 (16%)	67,82,82	1.67	11 (16%)
2	HEM	M	1503	1	50,50,50	2.00	10 (20%)	67,82,82	1.70	13 (19%)
2	HEM	G	1503	1	50,50,50	2.04	8 (16%)	67,82,82	1.76	15 (22%)
2	HEM	C	1503	1	50,50,50	1.77	8 (16%)	67,82,82	1.55	9 (13%)
2	HEM	N	1503	1	50,50,50	2.01	7 (14%)	67,82,82	1.61	13 (19%)
2	HEM	L	1503	1	50,50,50	1.91	7 (14%)	67,82,82	1.64	10 (14%)
2	HEM	F	1503	1	50,50,50	1.98	9 (18%)	67,82,82	1.63	12 (17%)

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

Mol	Type	Chain	Res	Link	Chirals	Torsions	Rings
2	HEM	B	1503	1	-	2/14/54/54	-
2	HEM	O	1503	1	-	4/14/54/54	-
2	HEM	D	1503	1	-	4/14/54/54	-
2	HEM	P	1503	1	-	4/14/54/54	-
2	HEM	I	1503	1	-	2/14/54/54	-
2	HEM	H	1503	1	-	4/14/54/54	-
2	HEM	J	1503	1	-	4/14/54/54	-
2	HEM	E	1503	1	-	4/14/54/54	-

Continued on next page...

Continued from previous page...

Mol	Type	Chain	Res	Link	Chirals	Torsions	Rings
2	HEM	K	1503	1	-	6/14/54/54	-
2	HEM	M	1503	1	-	4/14/54/54	-
2	HEM	G	1503	1	-	4/14/54/54	-
2	HEM	C	1503	1	-	4/14/54/54	-
2	HEM	N	1503	1	-	4/14/54/54	-
2	HEM	L	1503	1	-	4/14/54/54	-
2	HEM	F	1503	1	-	4/14/54/54	-

The worst 5 of 130 bond length outliers are listed below:

Mol	Chain	Res	Type	Atoms	Z	Observed(Å)	Ideal(Å)
2	B	1503	HEM	C3D-C2D	8.40	1.54	1.36
2	F	1503	HEM	C3D-C2D	8.01	1.54	1.36
2	H	1503	HEM	C3D-C2D	7.97	1.54	1.36
2	J	1503	HEM	C3D-C2D	7.86	1.53	1.36
2	K	1503	HEM	C3D-C2D	7.83	1.53	1.36

The worst 5 of 172 bond angle outliers are listed below:

Mol	Chain	Res	Type	Atoms	Z	Observed(°)	Ideal(°)
2	G	1503	HEM	C4D-ND-C1D	6.91	113.39	105.21
2	M	1503	HEM	C4D-ND-C1D	6.80	113.26	105.21
2	E	1503	HEM	C4D-ND-C1D	6.61	113.03	105.21
2	I	1503	HEM	C4D-ND-C1D	6.48	112.88	105.21
2	D	1503	HEM	C4D-ND-C1D	6.34	112.71	105.21

There are no chirality outliers.

5 of 58 torsion outliers are listed below:

Mol	Chain	Res	Type	Atoms
2	C	1503	HEM	C2C-C3C-CAC-CBC
2	C	1503	HEM	C4C-C3C-CAC-CBC
2	D	1503	HEM	C2C-C3C-CAC-CBC
2	D	1503	HEM	C4C-C3C-CAC-CBC
2	E	1503	HEM	C2C-C3C-CAC-CBC

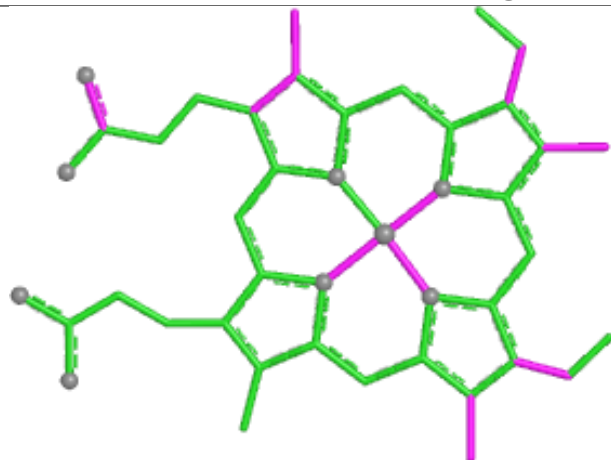
There are no ring outliers.

15 monomers are involved in 68 short contacts:

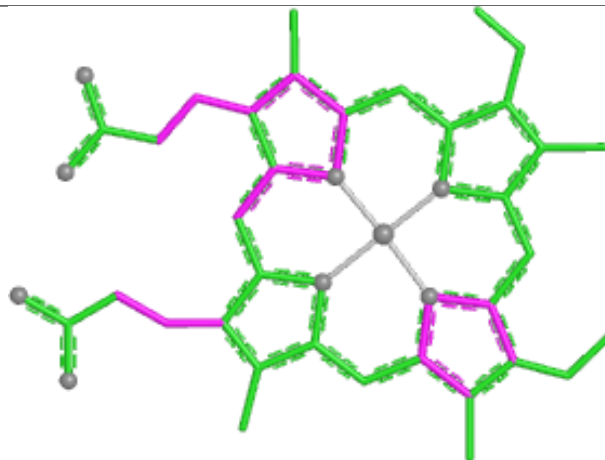
Mol	Chain	Res	Type	Clashes	Symm-Clashes
2	B	1503	HEM	6	0
2	O	1503	HEM	5	0
2	D	1503	HEM	4	0
2	P	1503	HEM	3	0
2	I	1503	HEM	1	0
2	H	1503	HEM	5	0
2	J	1503	HEM	6	0
2	E	1503	HEM	5	0
2	K	1503	HEM	7	0
2	M	1503	HEM	3	0
2	G	1503	HEM	3	0
2	C	1503	HEM	6	0
2	N	1503	HEM	5	0
2	L	1503	HEM	6	0
2	F	1503	HEM	3	0

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.

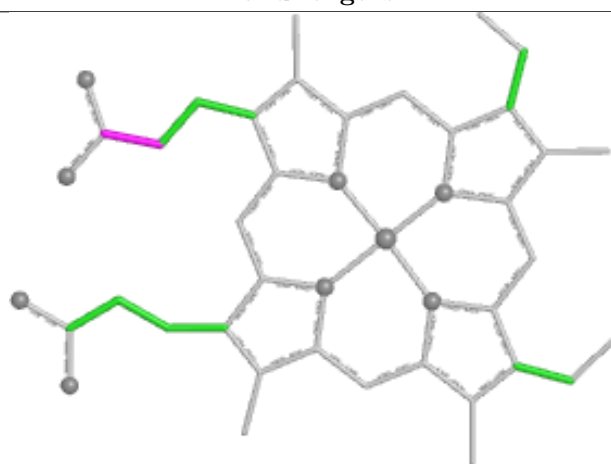
Ligand HEM B 1503



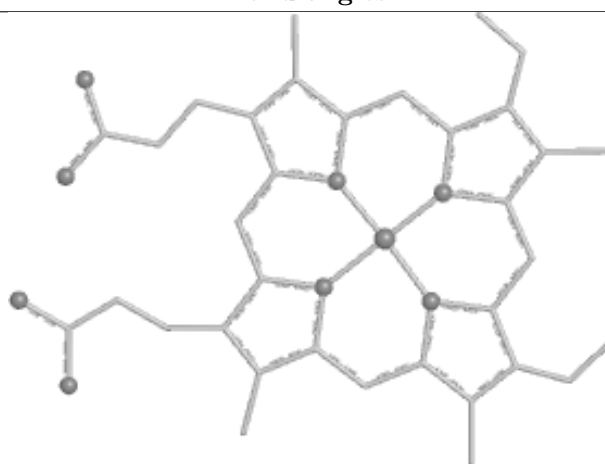
Bond lengths



Bond angles

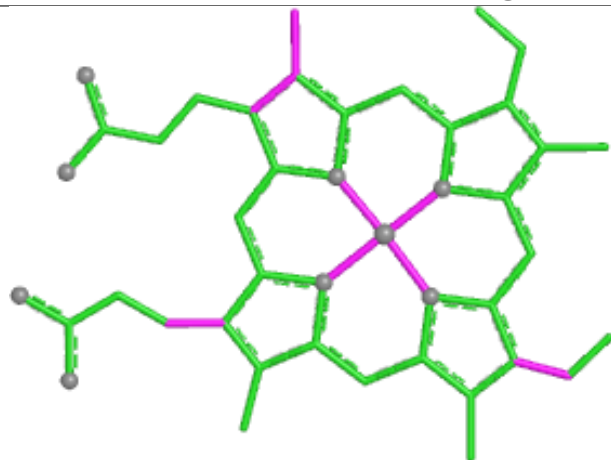


Torsions

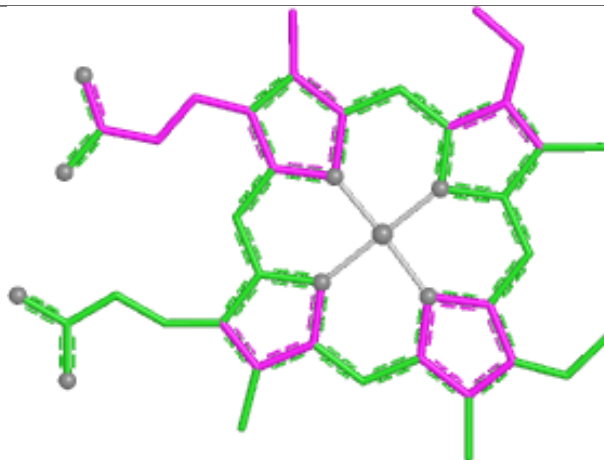


Rings

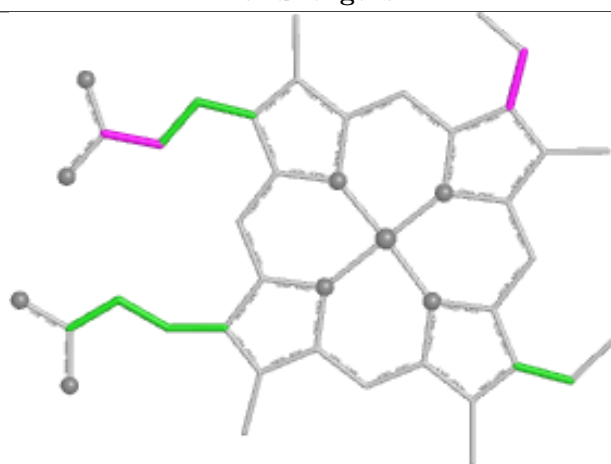
Ligand HEM O 1503



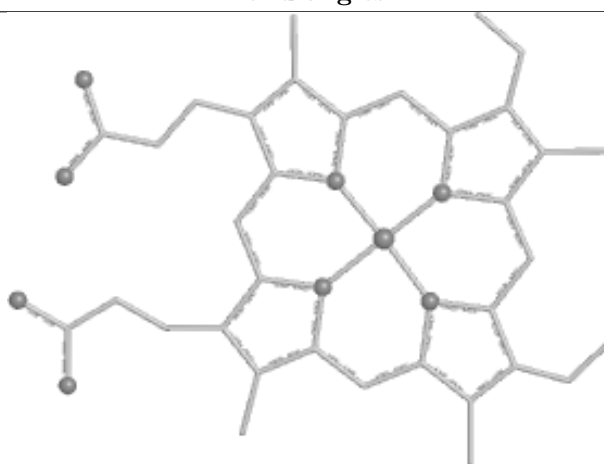
Bond lengths



Bond angles

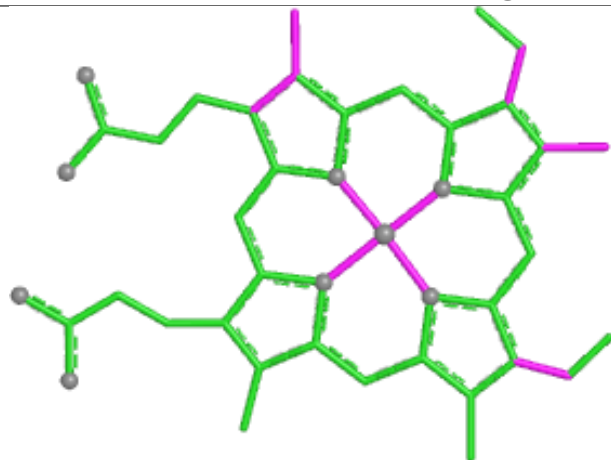


Torsions

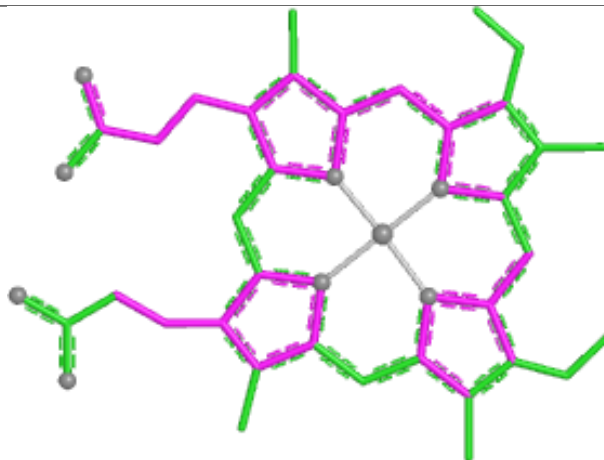


Rings

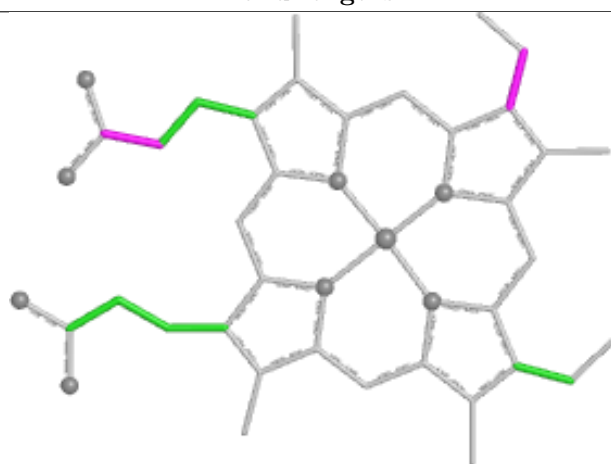
Ligand HEM D 1503



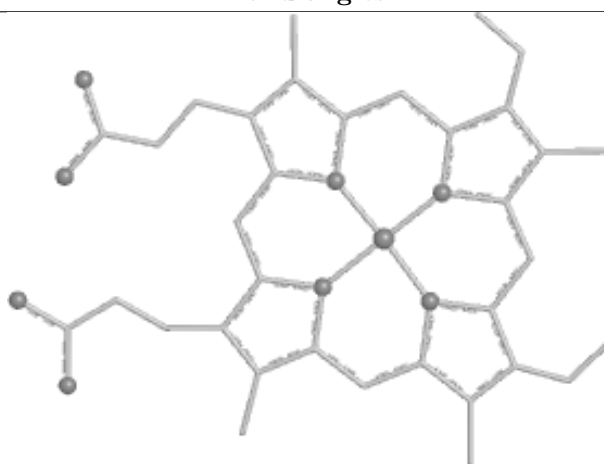
Bond lengths



Bond angles

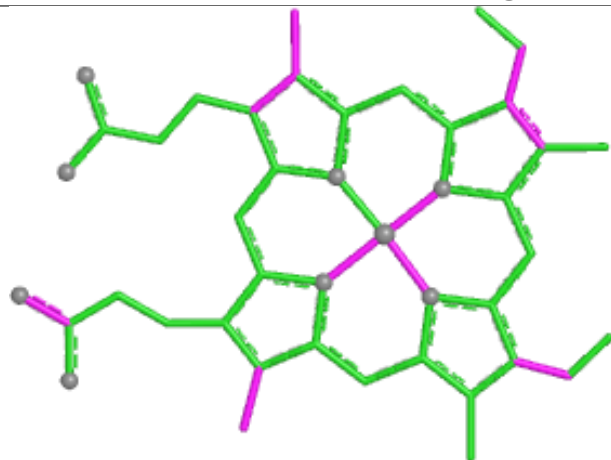


Torsions

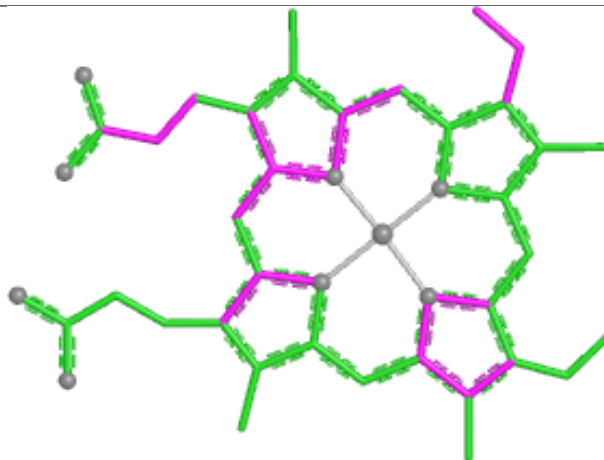


Rings

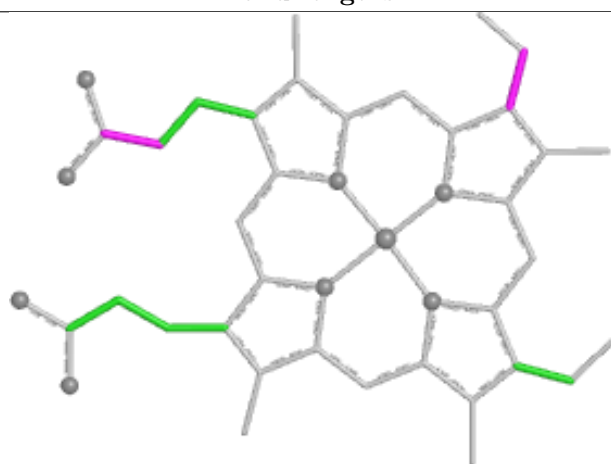
Ligand HEM P 1503



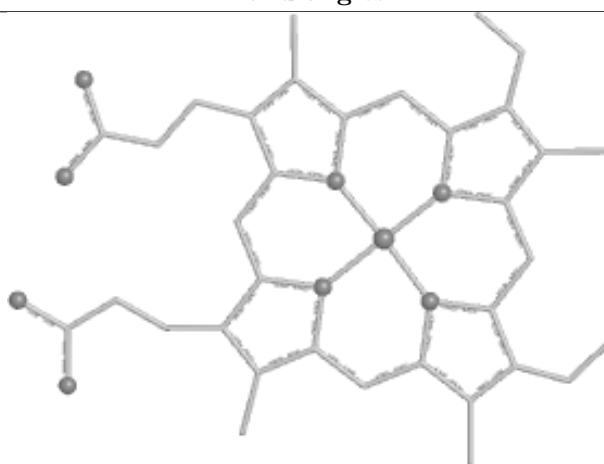
Bond lengths



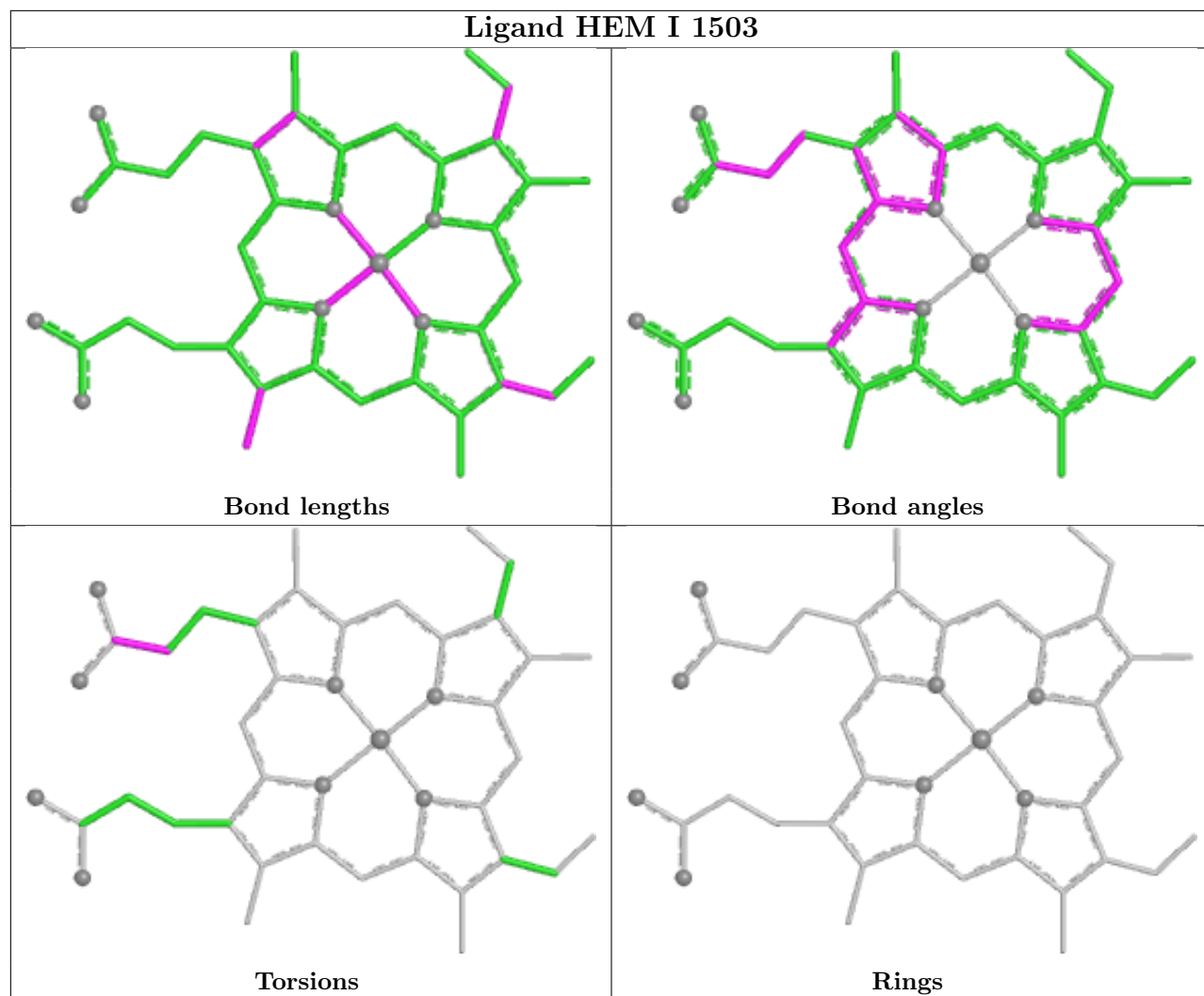
Bond angles



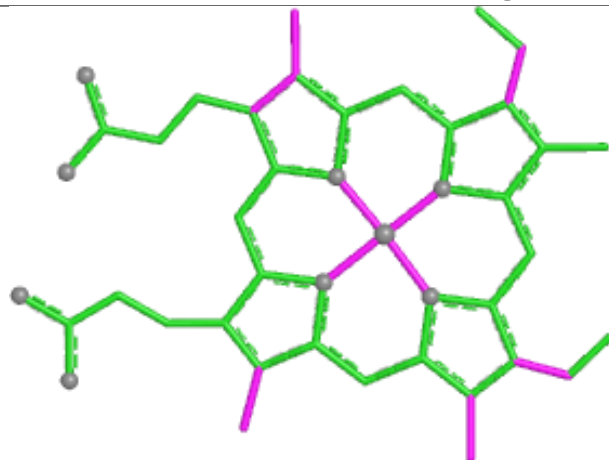
Torsions



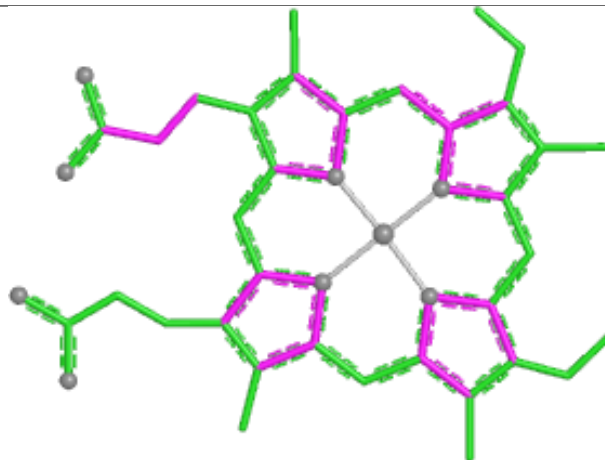
Rings



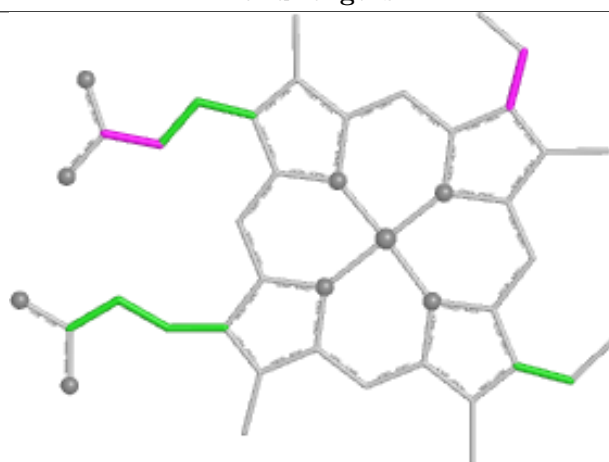
Ligand HEM H 1503



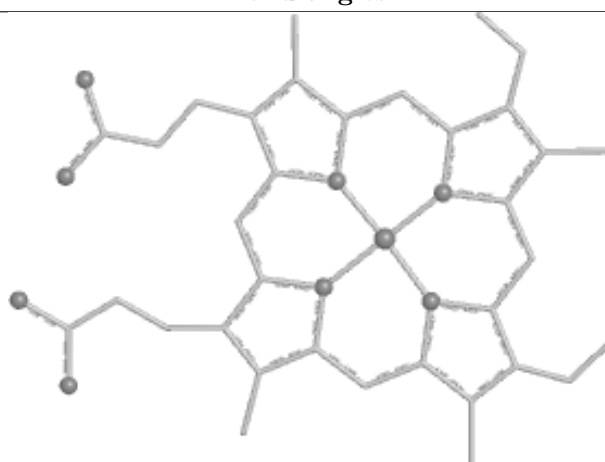
Bond lengths



Bond angles

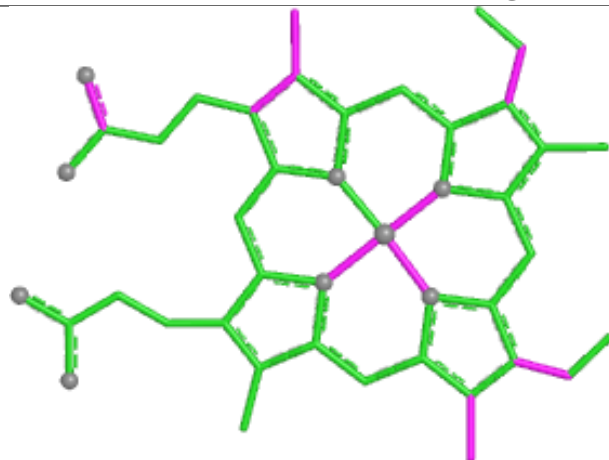


Torsions

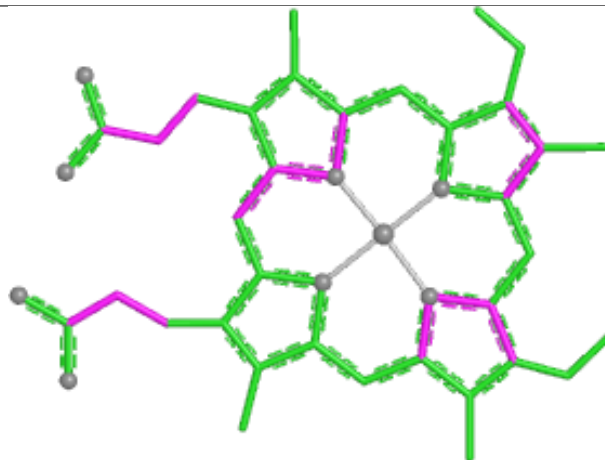


Rings

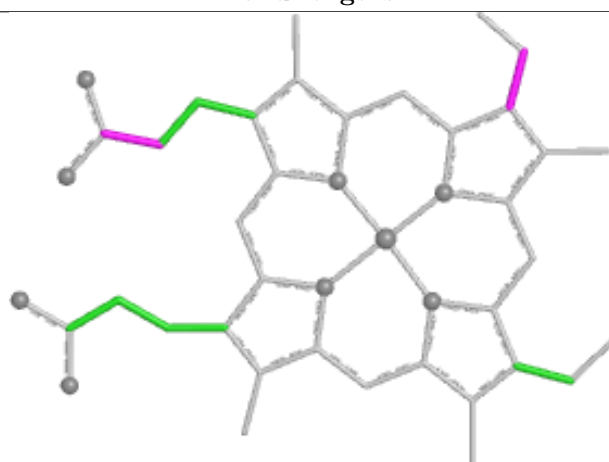
Ligand HEM J 1503



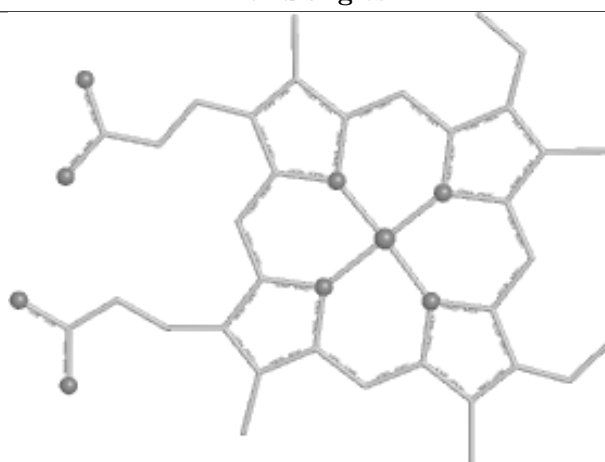
Bond lengths



Bond angles

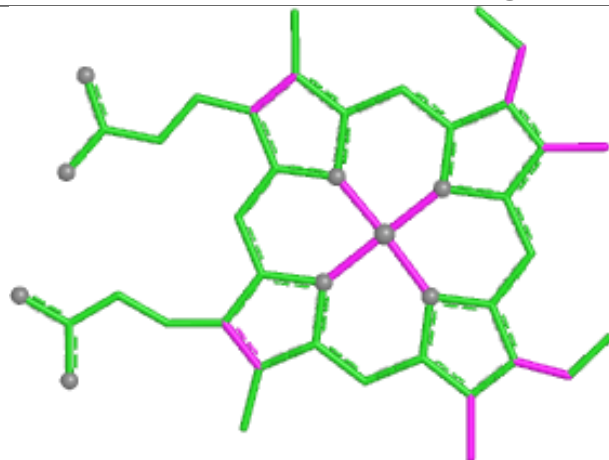


Torsions

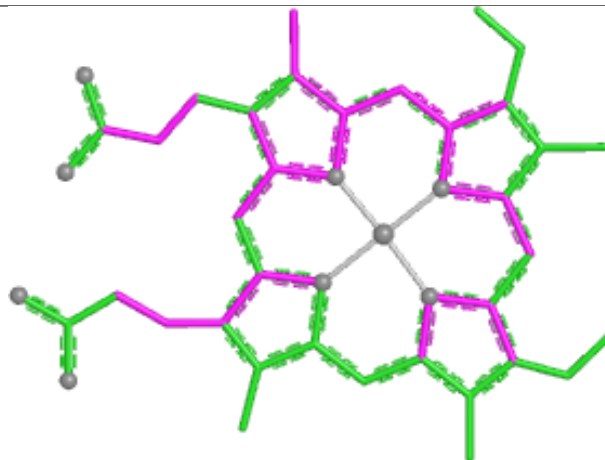


Rings

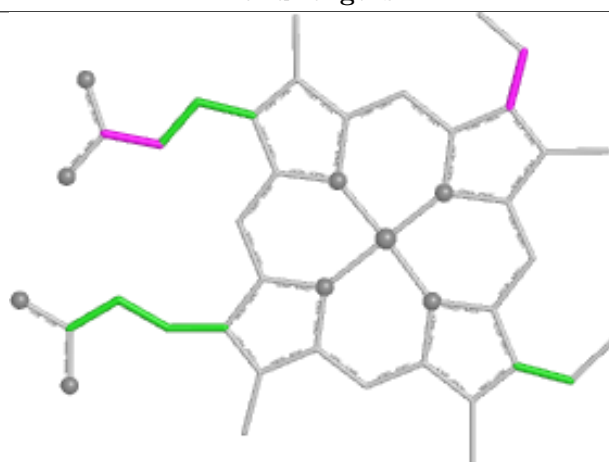
Ligand HEM E 1503



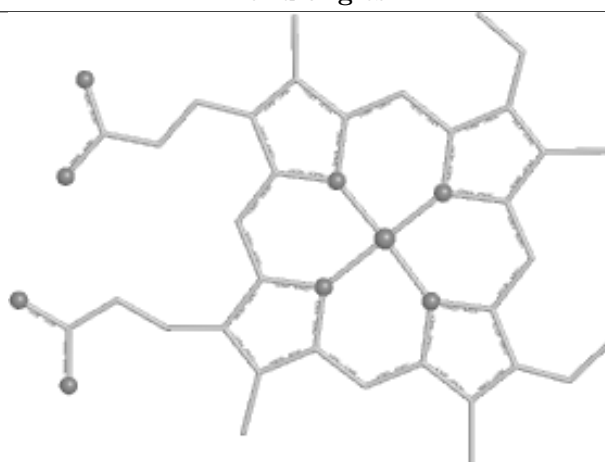
Bond lengths



Bond angles

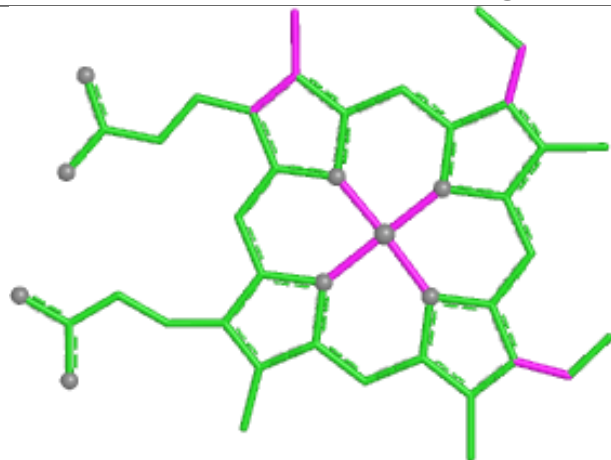


Torsions

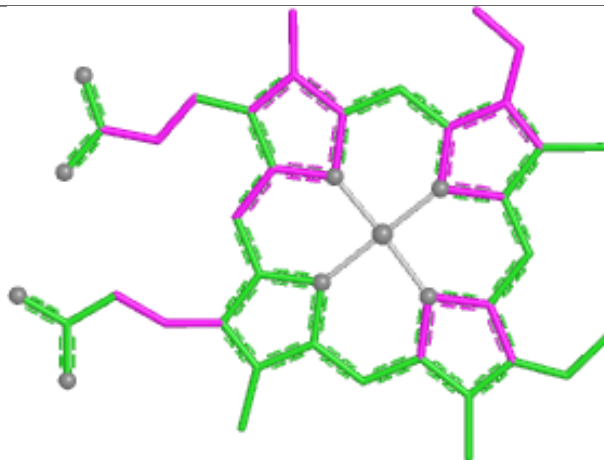


Rings

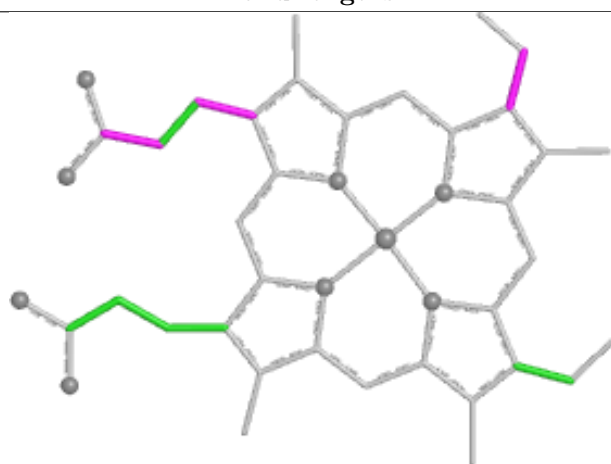
Ligand HEM K 1503



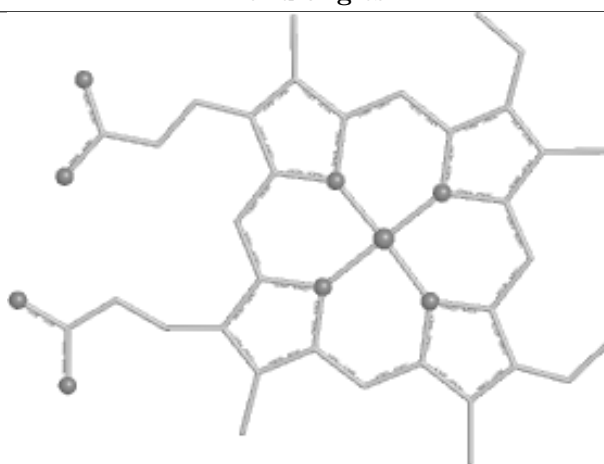
Bond lengths



Bond angles

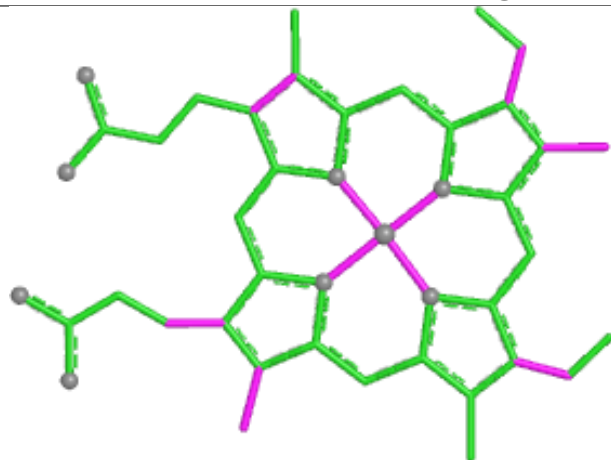


Torsions

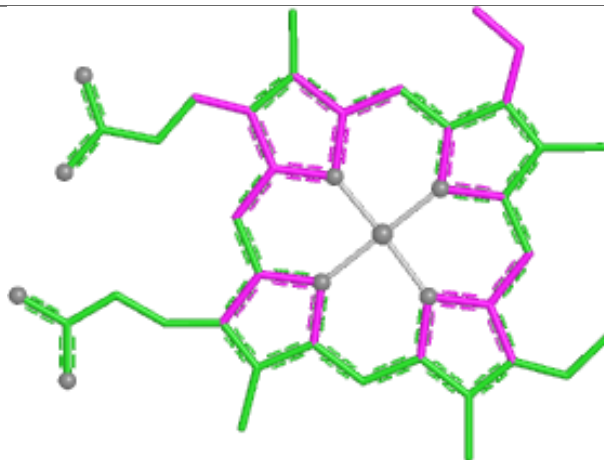


Rings

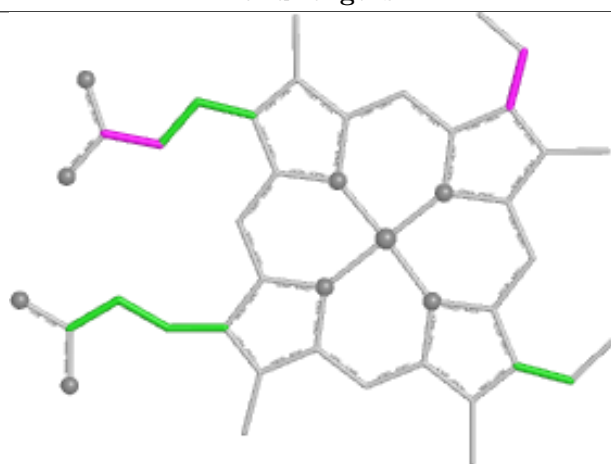
Ligand HEM M 1503



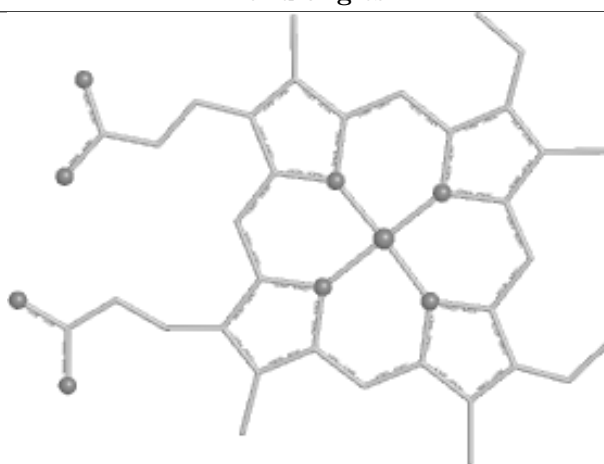
Bond lengths



Bond angles

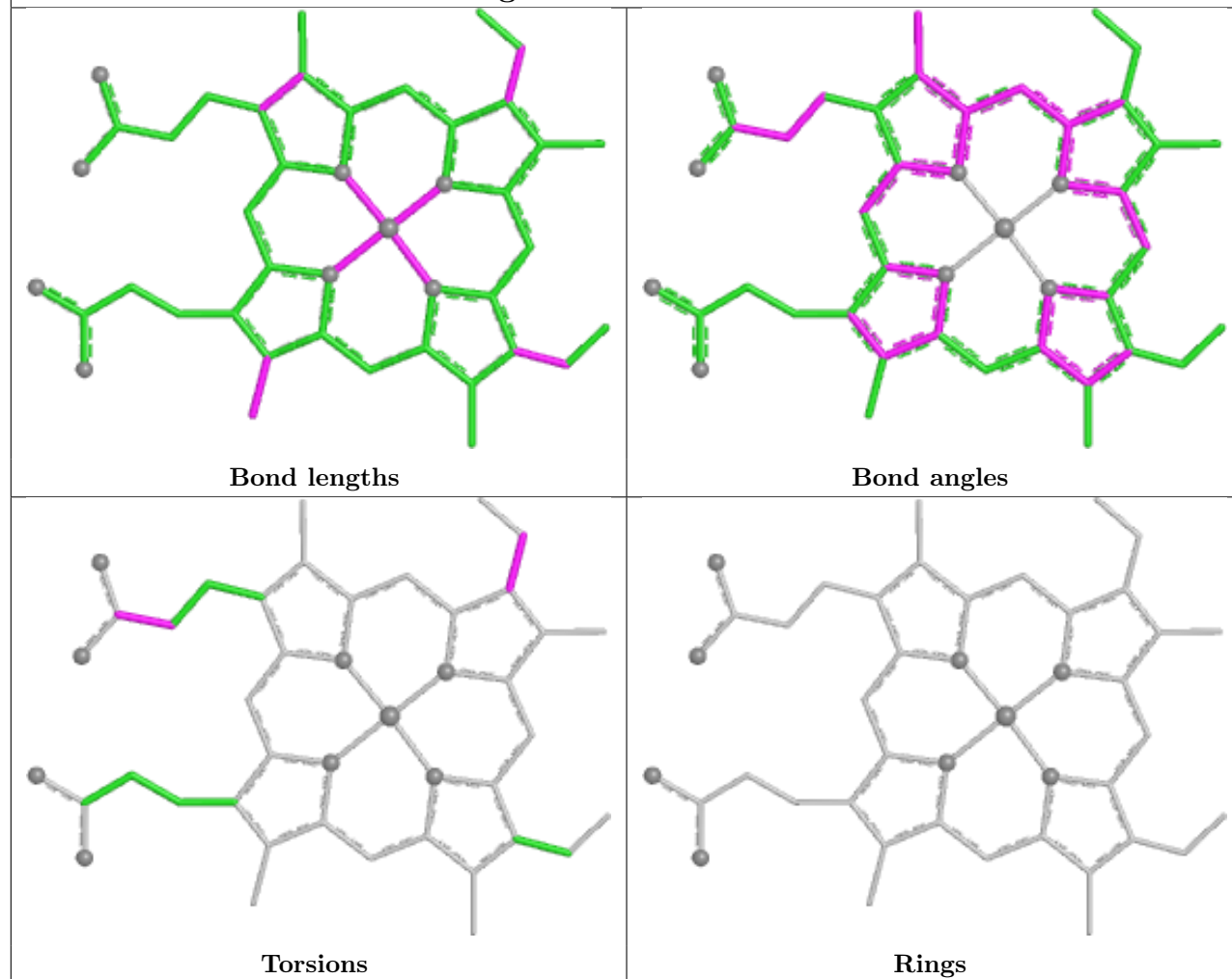


Torsions

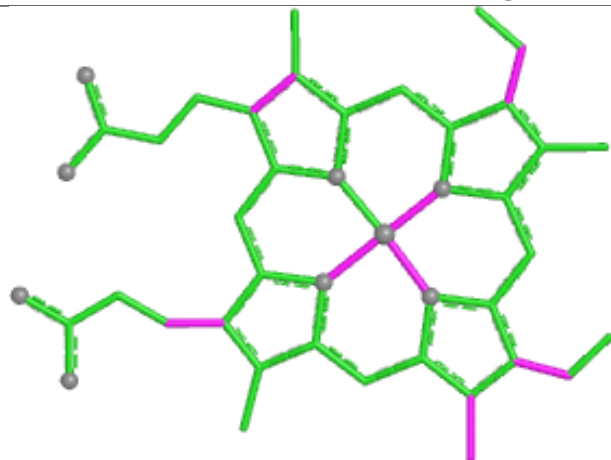


Rings

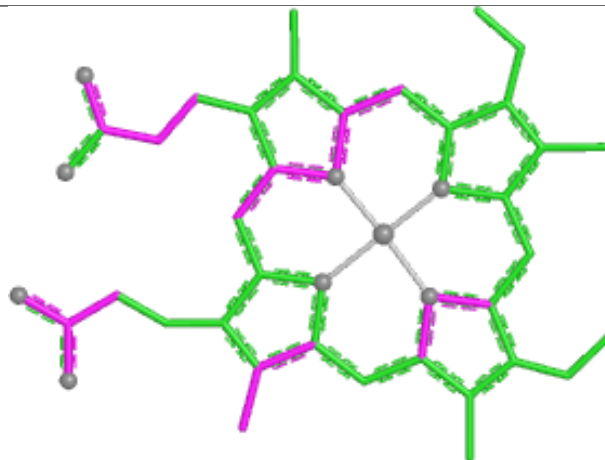
Ligand HEM G 1503



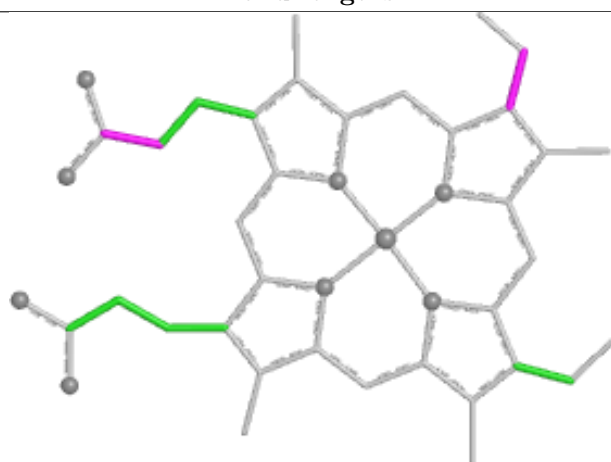
Ligand HEM C 1503



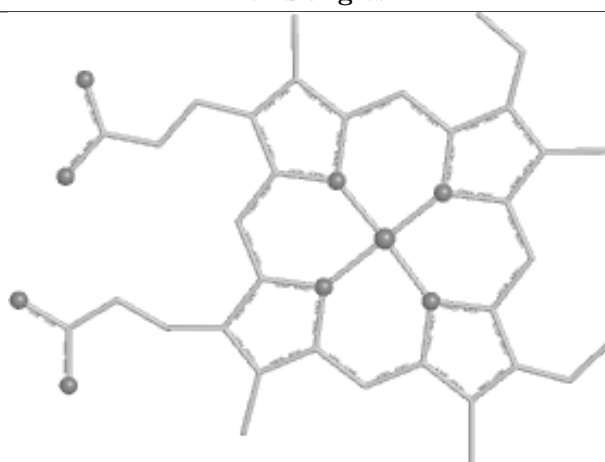
Bond lengths



Bond angles

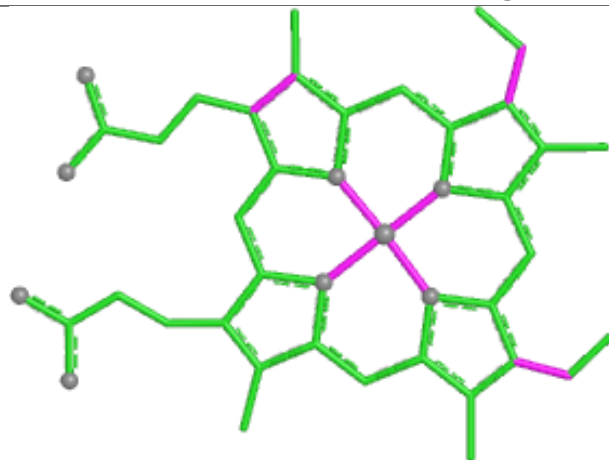


Torsions

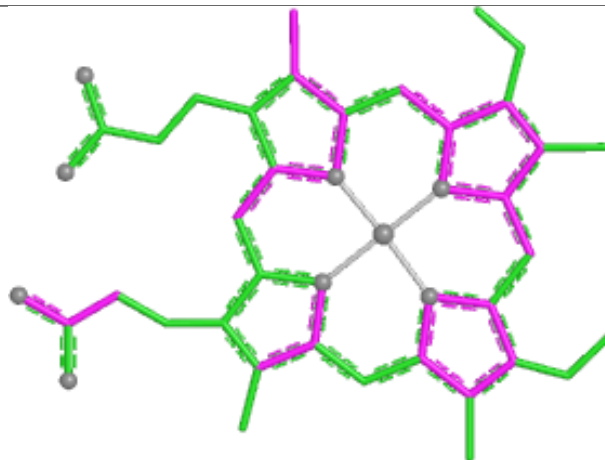


Rings

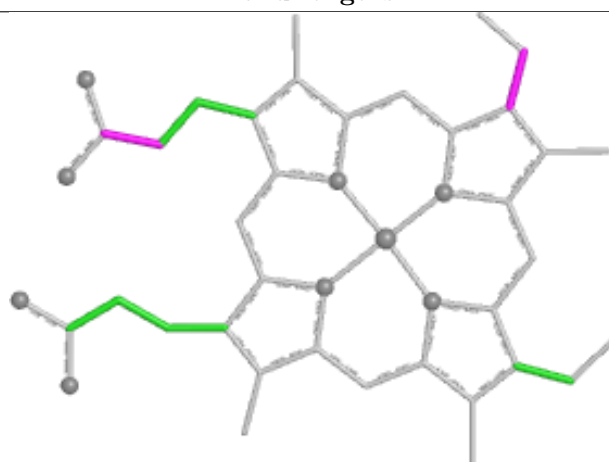
Ligand HEM N 1503



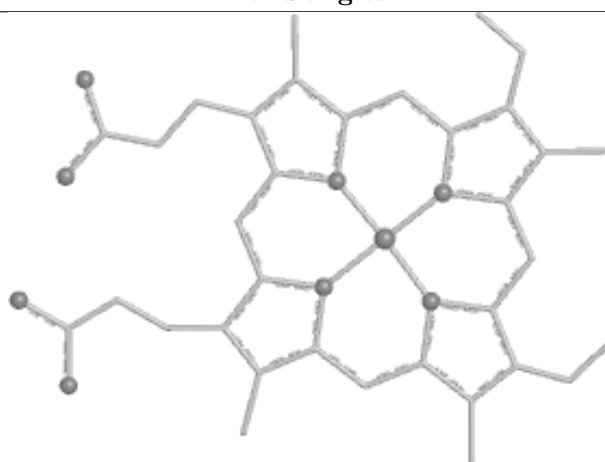
Bond lengths



Bond angles

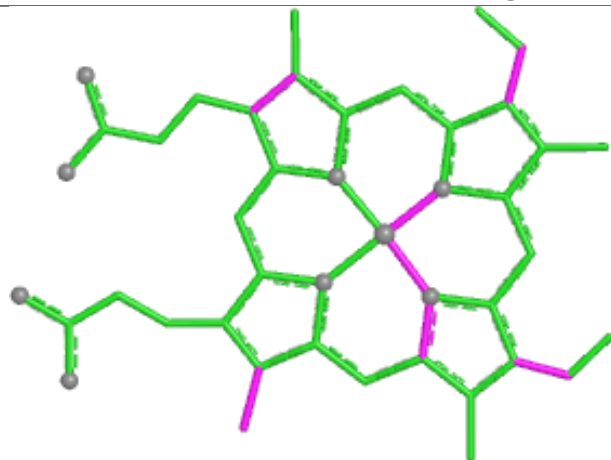


Torsions

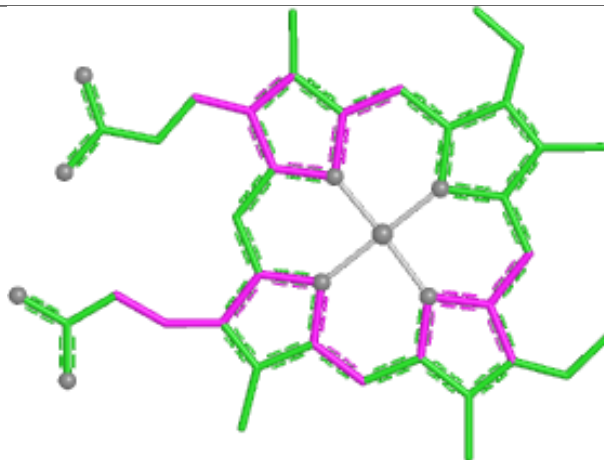


Rings

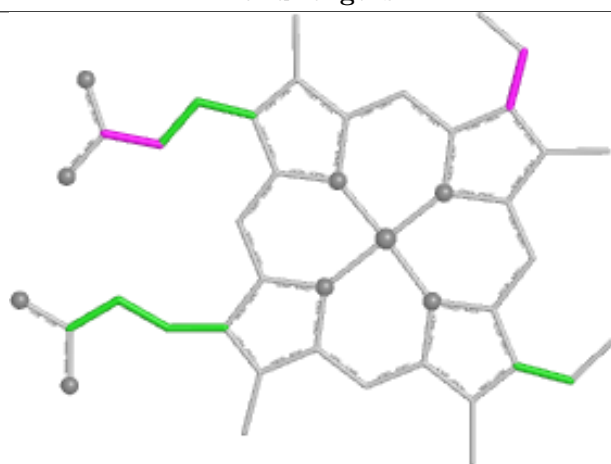
Ligand HEM L 1503



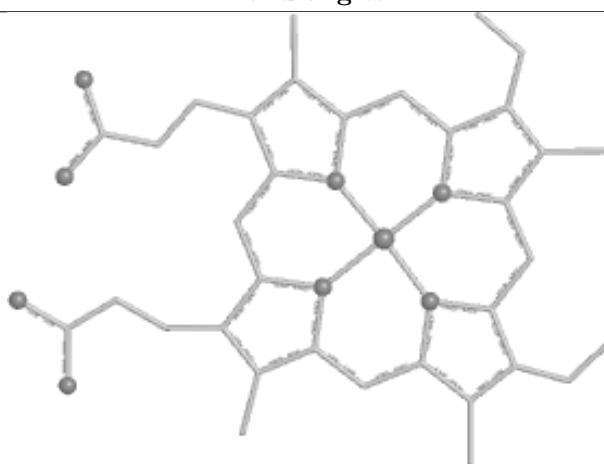
Bond lengths



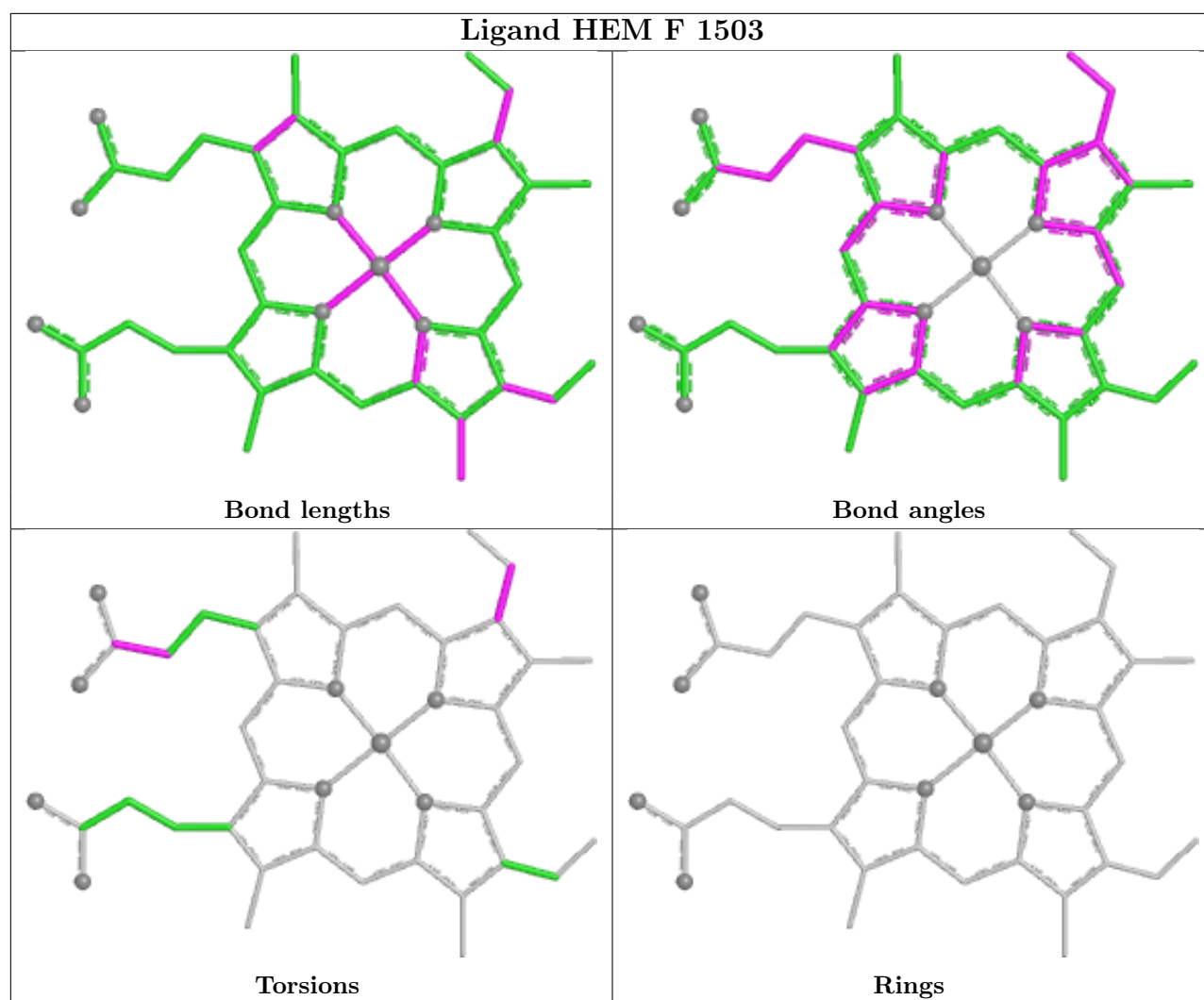
Bond angles



Torsions



Rings



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	491/509 (96%)	-0.37	0 100 100	21, 41, 67, 105	0
1	B	494/509 (97%)	-0.30	2 (0%) 88 85	20, 41, 68, 105	0
1	C	492/509 (96%)	-0.31	2 (0%) 88 85	20, 41, 68, 122	0
1	D	494/509 (97%)	-0.40	1 (0%) 91 89	20, 42, 69, 105	0
1	E	490/509 (96%)	-0.36	2 (0%) 88 85	20, 41, 68, 105	0
1	F	494/509 (97%)	-0.34	9 (1%) 67 59	20, 40, 69, 151	0
1	G	491/509 (96%)	-0.31	2 (0%) 88 85	20, 41, 68, 105	0
1	H	487/509 (95%)	-0.38	1 (0%) 91 89	21, 41, 68, 109	0
1	I	491/509 (96%)	-0.31	4 (0%) 82 77	20, 41, 69, 105	0
1	J	491/509 (96%)	-0.30	3 (0%) 85 81	21, 41, 68, 105	0
1	K	490/509 (96%)	-0.39	3 (0%) 85 81	20, 41, 69, 105	0
1	L	489/509 (96%)	-0.37	2 (0%) 88 85	21, 41, 69, 104	0
1	M	491/509 (96%)	-0.37	2 (0%) 88 85	22, 42, 69, 105	0
1	N	491/509 (96%)	-0.32	1 (0%) 91 89	22, 42, 69, 105	0
1	O	493/509 (96%)	-0.44	1 (0%) 91 89	21, 42, 70, 105	0
1	P	491/509 (96%)	-0.31	3 (0%) 85 81	21, 42, 70, 105	0
All	All	7860/8144 (96%)	-0.35	38 (0%) 87 83	20, 41, 69, 151	0

The worst 5 of 38 RSRZ outliers are listed below:

Mol	Chain	Res	Type	RSRZ
1	F	501	ALA	6.6
1	L	501	ALA	6.2
1	M	501	ALA	6.1
1	K	501	ALA	6.0
1	E	501	ALA	5.9

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

There are no non-standard protein/DNA/RNA residues in this entry.

6.3 Carbohydrates [i](#)

There are no oligosaccharides in this entry.

6.4 Ligands [i](#)

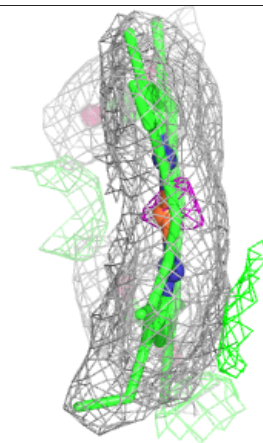
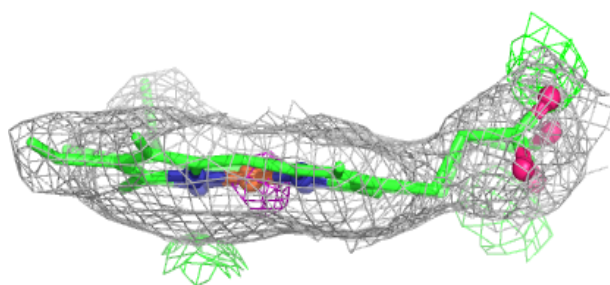
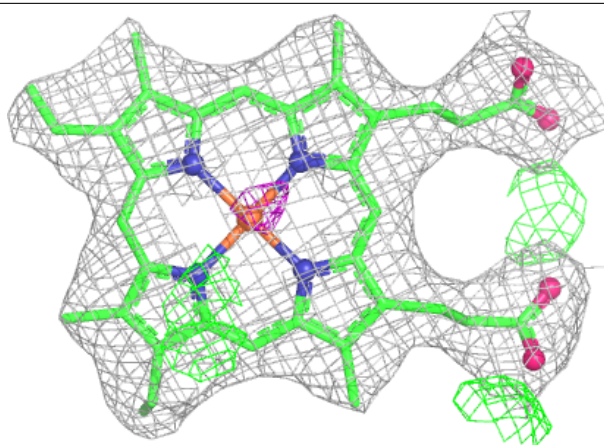
In the following table, the Atoms column lists the number of modelled atoms in the group and the number defined in the chemical component dictionary. The B-factors column lists the minimum, median, 95th percentile and maximum values of B factors of atoms in the group. The column labelled 'Q< 0.9' lists the number of atoms with occupancy less than 0.9.

Mol	Type	Chain	Res	Atoms	RSCC	RSR	B-factors($\text{\AA}^2$)	Q<0.9
2	HEM	C	1503	43/43	0.96	0.07	19,25,31,34	0
2	HEM	D	1503	43/43	0.96	0.07	21,32,36,40	0
2	HEM	E	1503	43/43	0.96	0.08	22,30,35,38	0
2	HEM	H	1503	43/43	0.96	0.07	22,41,45,47	0
2	HEM	N	1503	43/43	0.96	0.08	28,37,39,41	0
2	HEM	O	1503	43/43	0.96	0.08	20,32,35,39	0
2	HEM	B	1503	43/43	0.97	0.06	16,26,31,34	0
2	HEM	I	1503	43/43	0.97	0.07	25,34,39,43	0
2	HEM	J	1503	43/43	0.97	0.07	24,34,39,41	0
2	HEM	K	1503	43/43	0.97	0.07	20,30,35,38	0
2	HEM	L	1503	43/43	0.97	0.07	22,27,31,35	0
2	HEM	M	1503	43/43	0.97	0.07	27,33,37,39	0
2	HEM	F	1503	43/43	0.97	0.07	17,25,29,34	0
2	HEM	G	1503	43/43	0.97	0.07	19,24,29,32	0
2	HEM	P	1503	43/43	0.97	0.07	31,41,44,46	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.

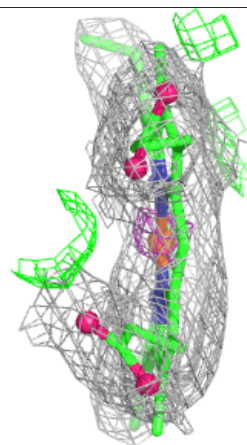
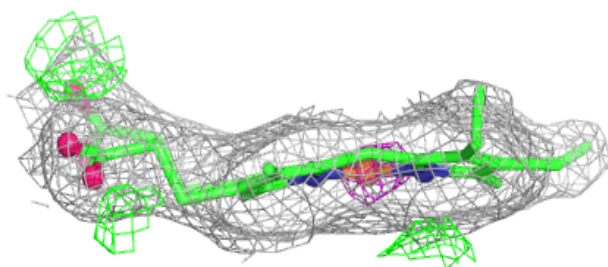
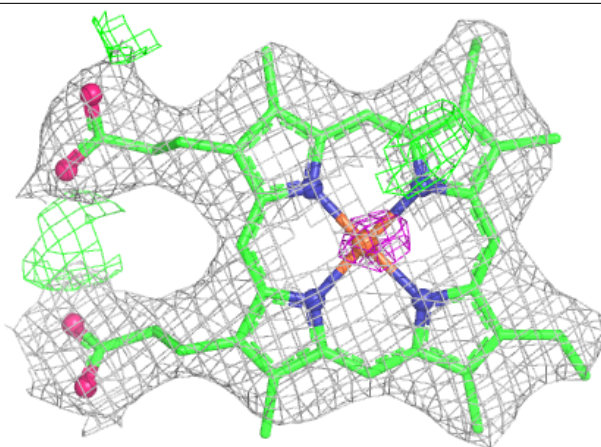
Electron density around HEM C 1503:

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



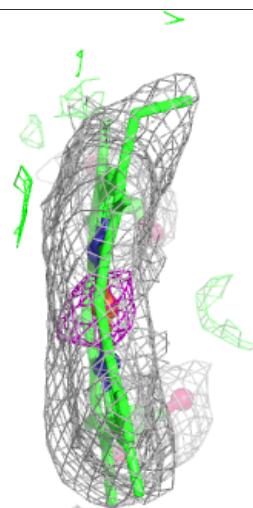
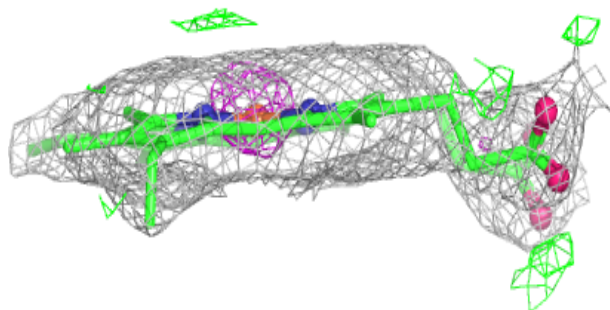
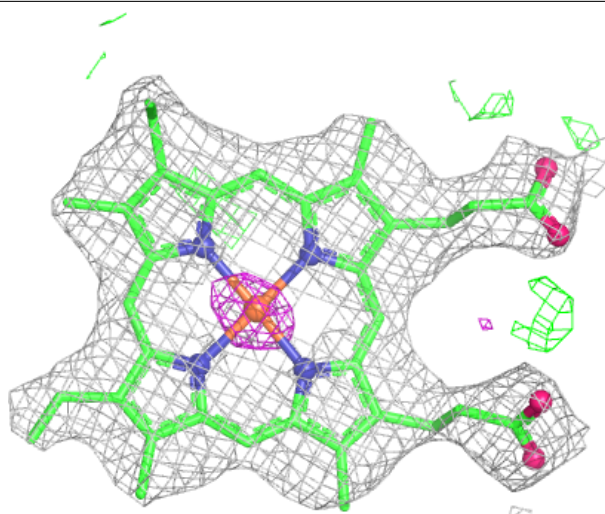
Electron density around HEM D 1503:

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



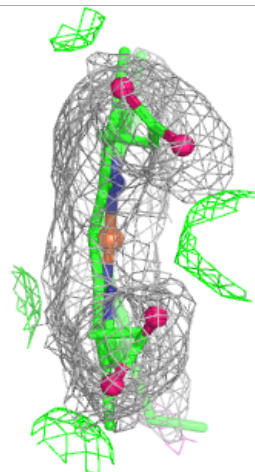
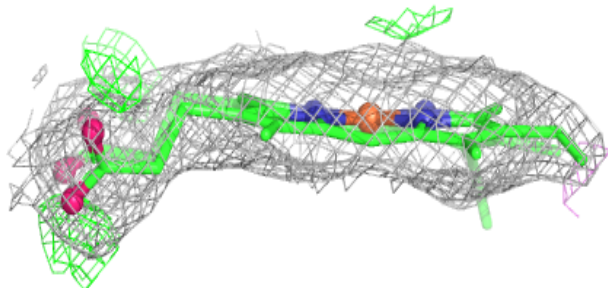
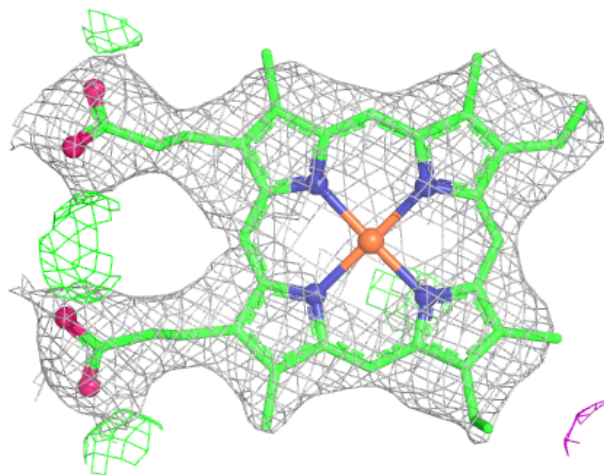
Electron density around HEM E 1503:

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



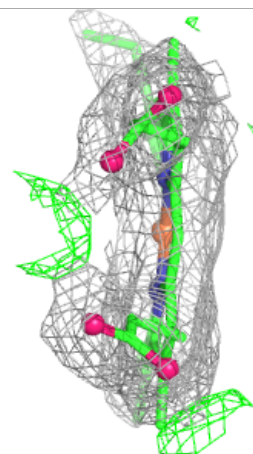
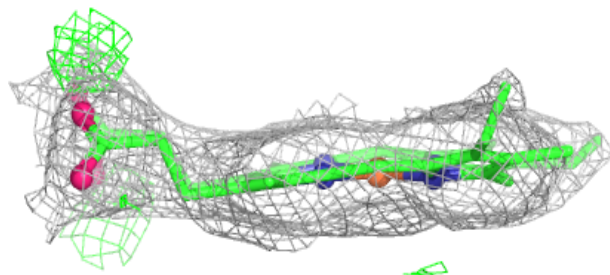
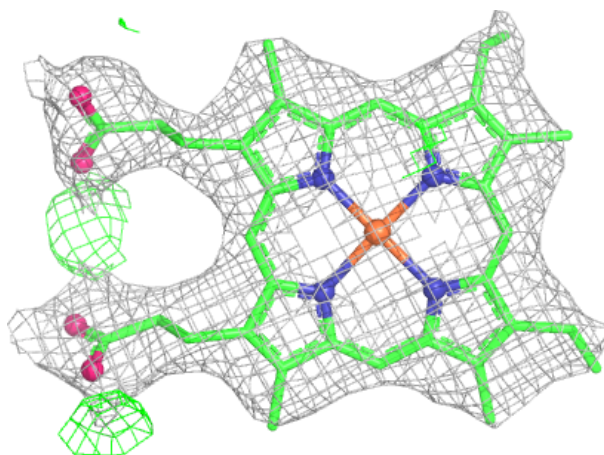
Electron density around HEM H 1503:

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



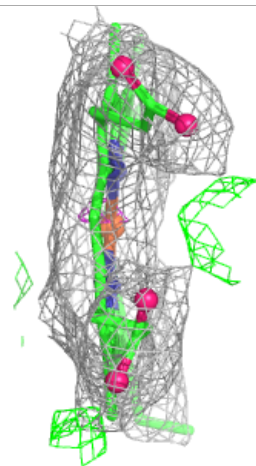
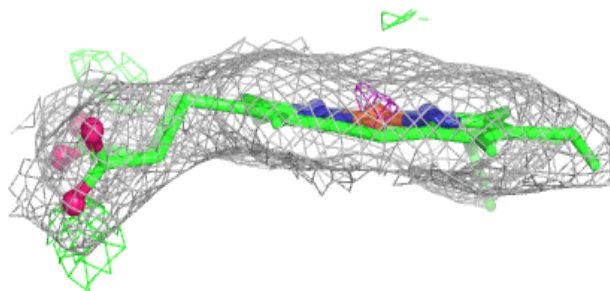
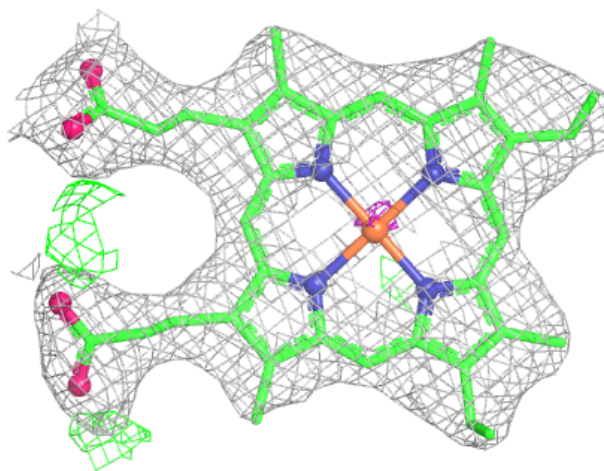
Electron density around HEM N 1503:

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



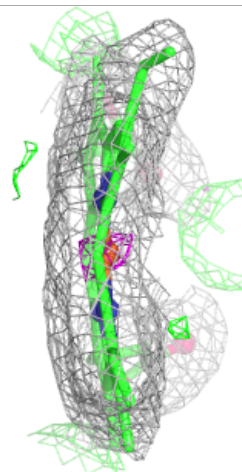
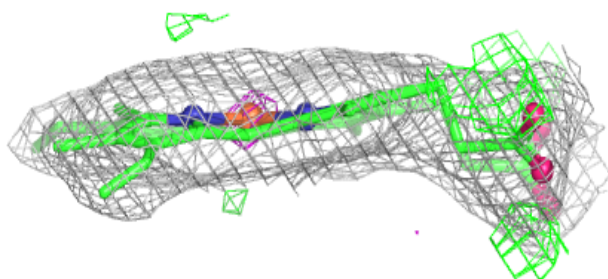
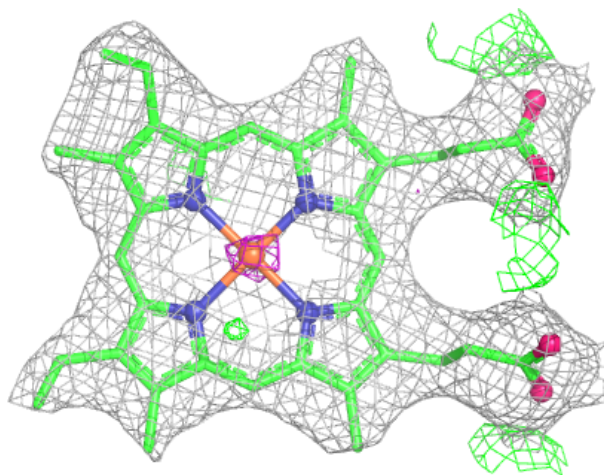
Electron density around HEM O 1503:

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



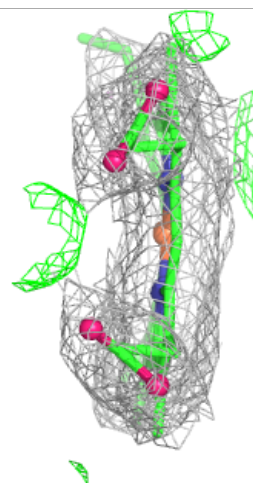
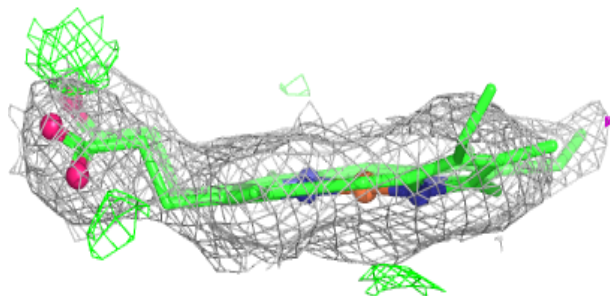
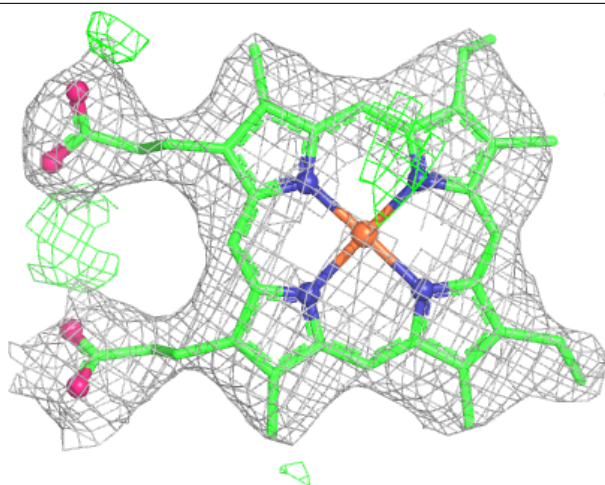
Electron density around HEM B 1503:

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



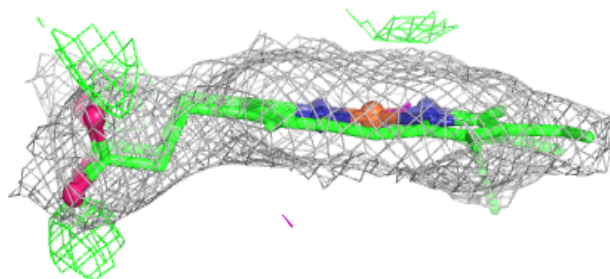
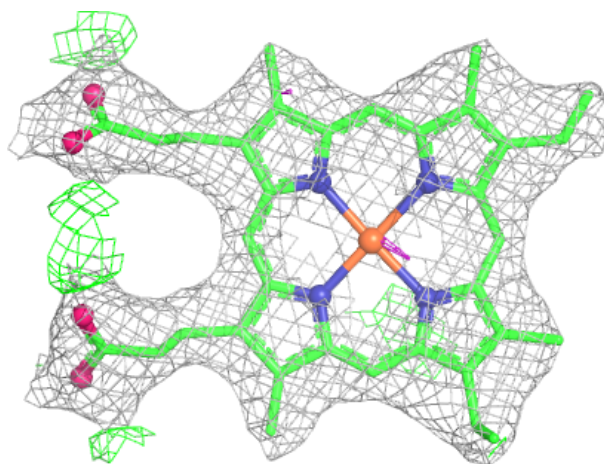
Electron density around HEM I 1503:

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



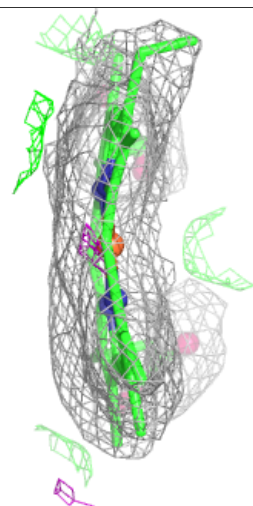
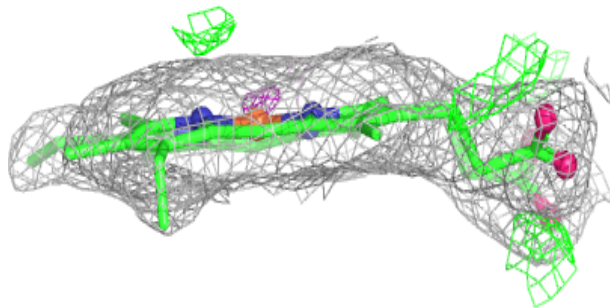
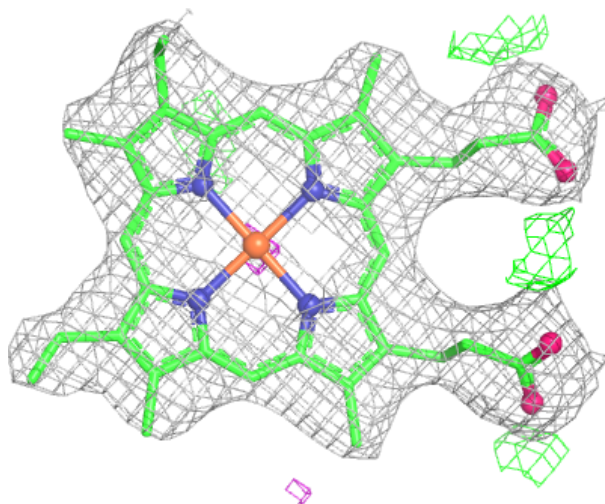
Electron density around HEM J 1503:

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



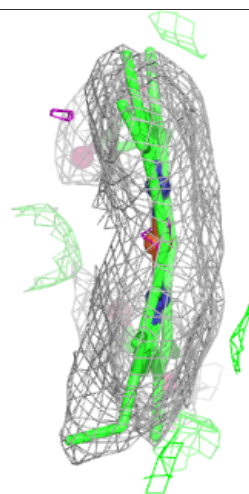
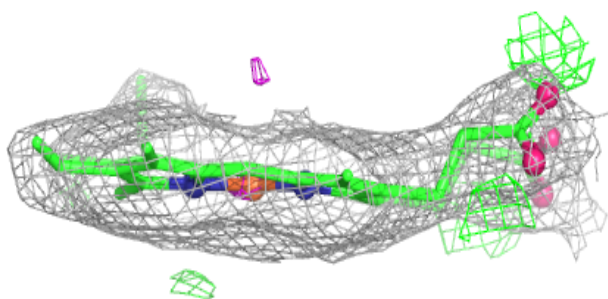
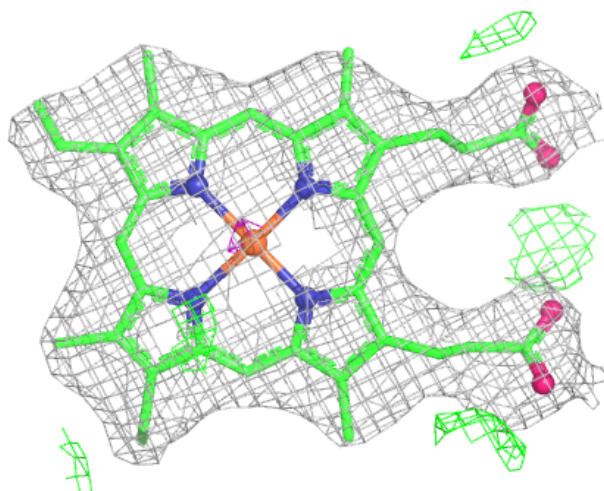
Electron density around HEM K 1503:

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



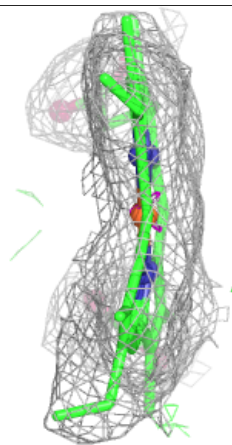
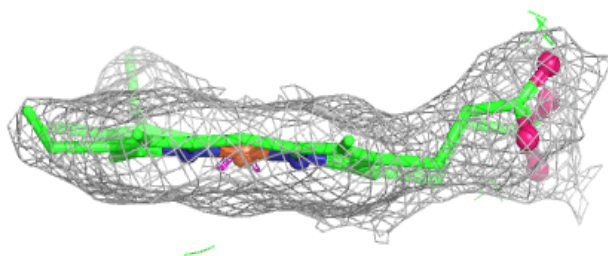
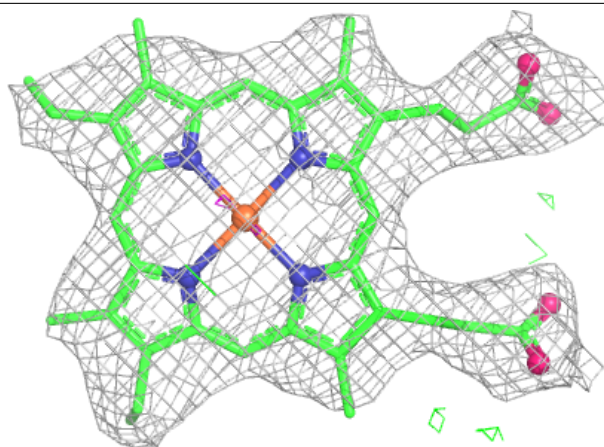
Electron density around HEM L 1503:

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



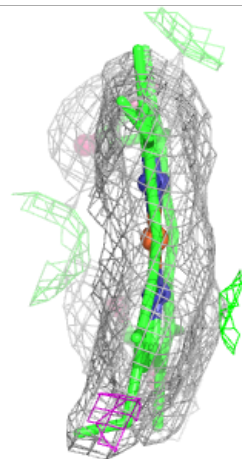
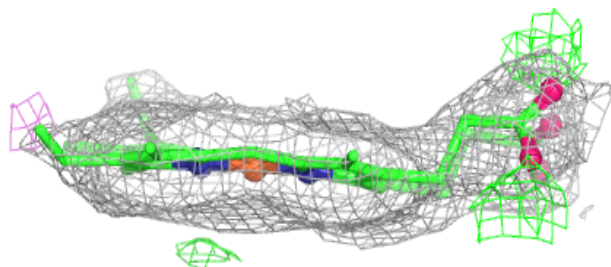
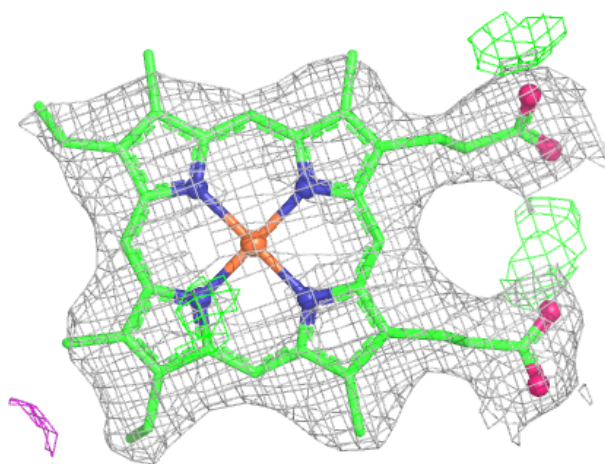
Electron density around HEM M 1503:

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



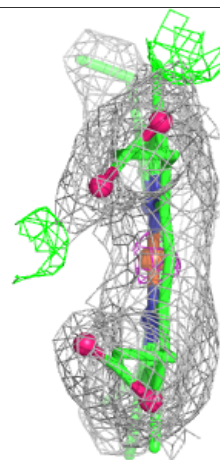
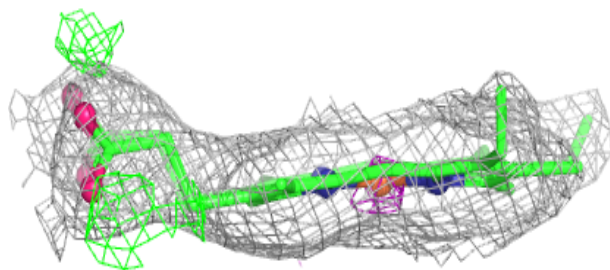
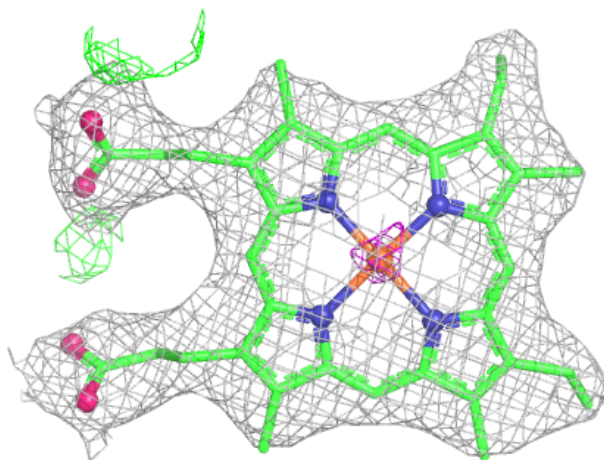
Electron density around HEM F 1503:

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



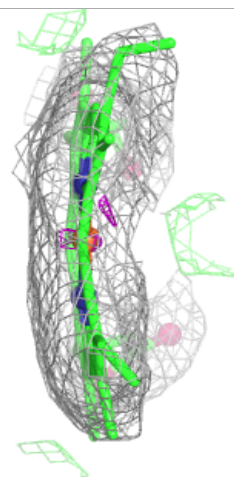
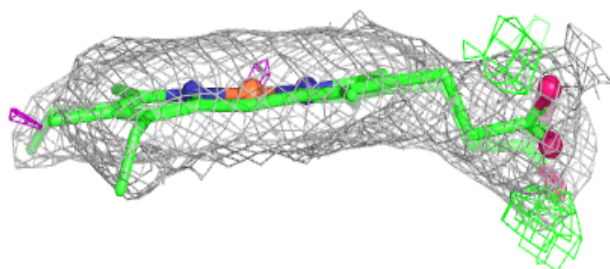
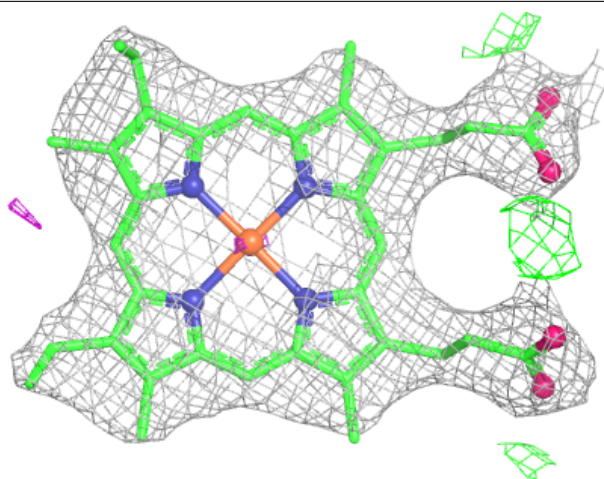
Electron density around HEM G 1503:

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



Electron density around HEM P 1503:

$2mF_o-DF_c$ (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.