Full wwPDB X-ray Structure Validation Report (i)

Sep 5, 2023 – 05:50 PM EDT

PDB ID	:	4DUD
Title	:	cytochrome P450 BM3h-2G9C6 MRI sensor, no ligand
Authors	:	Brustad, E.M.; Lelyveld, V.S.; Snow, C.D.; Crook, N.; Martinez, F.M.; Scholl, T.J.; Jasanoff, A.; Arnold, F.H.
Deposited on	:	2012-02-21
Resolution	:	1.85 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 (i) 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 (i)) were used in the production of this report:

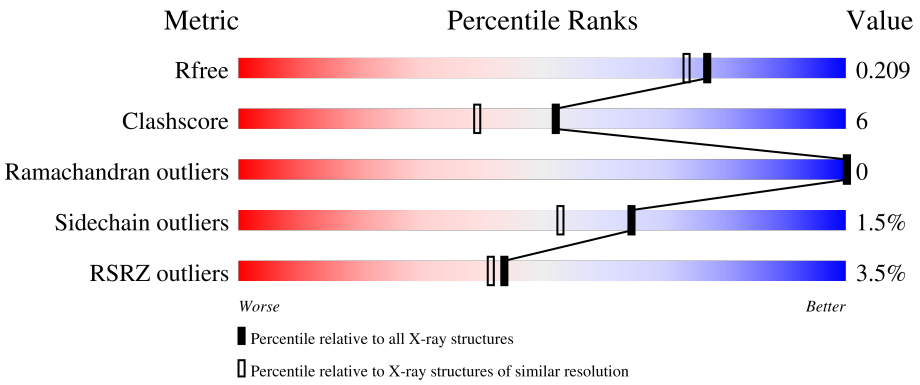
MolProbity	:	4.02b-467
Mogul	:	1.8.5 (274361), CSD as541be (2020)
Xtriage (Phenix)	:	1.13
EDS	:	2.35
buster-report	:	1.1.7 (2018)
Percentile statistics	:	20191225.v01 (using entries in the PDB archive December 25th 2019)
Refmac	:	5.8.0158
CCP4	:	7.0.044 (Gargrove)
Ideal geometry (proteins)	:	Engh & Huber (2001)
Ideal geometry (DNA, RNA)	:	Parkinson et al. (1996)
Validation Pipeline (wwPDB-VP)	:	2.35

1 Overall quality at a glance (i)

The following experimental techniques were used to determine the structure:
X-RAY DIFFRACTION

The reported resolution of this entry is 1.85 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	2469 (1.86-1.86)
Clashscore	141614	2625 (1.86-1.86)
Ramachandran outliers	138981	2592 (1.86-1.86)
Sidechain outliers	138945	2592 (1.86-1.86)
RSRZ outliers	127900	2436 (1.86-1.86)

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 <=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	471	3% 85% 11% •
1	B	471	4% 84% 12% • •

2 Entry composition (i)

There are 3 unique types of molecules in this entry. The entry contains 8137 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 cytochrome P450 BM3 variant 2G9C6.

Mol	Chain	Residues	Atoms					ZeroOcc	AltConf	Trace
			Total	C	N	O	S			
1	A	456	3743	2382	638	704	19	0	12	0
1	B	456	3746	2391	640	696	19	0	13	0

There are 26 discrepancies between the modelled and reference sequences:

Chain	Residue	Modelled	Actual	Comment	Reference
A	50	CYS	ARG	engineered mutation	UNP P14779
A	87	LEU	PHE	engineered mutation	UNP P14779
A	268	SER	THR	engineered mutation	UNP P14779
A	437	GLN	LEU	engineered mutation	UNP P14779
A	438	LEU	THR	engineered mutation	UNP P14779
A	464	LEU	-	expression tag	UNP P14779
A	465	GLU	-	expression tag	UNP P14779
A	466	HIS	-	expression tag	UNP P14779
A	467	HIS	-	expression tag	UNP P14779
A	468	HIS	-	expression tag	UNP P14779
A	469	HIS	-	expression tag	UNP P14779
A	470	HIS	-	expression tag	UNP P14779
A	471	HIS	-	expression tag	UNP P14779
B	50	CYS	ARG	engineered mutation	UNP P14779
B	87	LEU	PHE	engineered mutation	UNP P14779
B	268	SER	THR	engineered mutation	UNP P14779
B	437	GLN	LEU	engineered mutation	UNP P14779
B	438	LEU	THR	engineered mutation	UNP P14779
B	464	LEU	-	expression tag	UNP P14779
B	465	GLU	-	expression tag	UNP P14779
B	466	HIS	-	expression tag	UNP P14779
B	467	HIS	-	expression tag	UNP P14779
B	468	HIS	-	expression tag	UNP P14779
B	469	HIS	-	expression tag	UNP P14779
B	470	HIS	-	expression tag	UNP P14779

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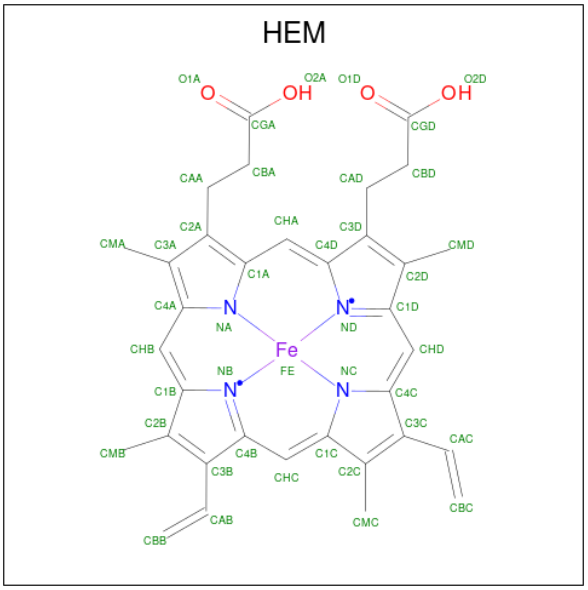
Chain	Residue	Modelled	Actual	Comment	Reference
B	471	HIS	-	expression tag	UNP P14779

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



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

- Molecule 3 is water.

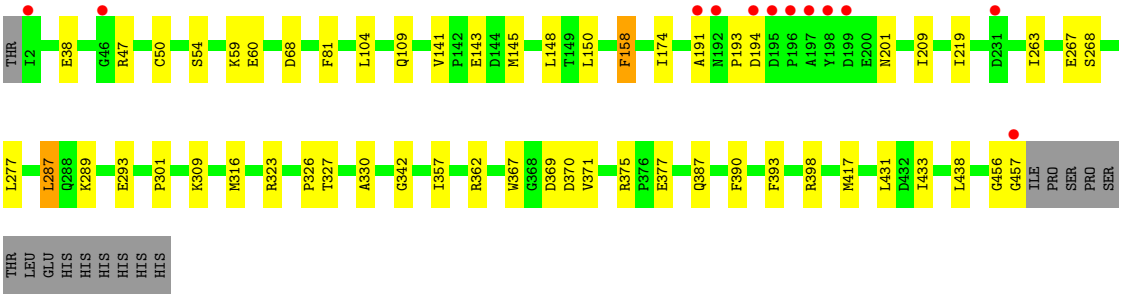
Mol	Chain	Residues	Atoms		ZeroOcc	AltConf
			Total	O		
3	A	289	289	289	0	0
			Total	O		
3	B	273	273	273	0	0

3 Residue-property plots (i)

These plots are drawn for all protein, RNA, DNA and oligosaccharide chains in the entry. The first graphic for a chain summarises the proportions of the various outlier classes displayed in the second graphic. The second graphic shows the sequence view annotated by issues in geometry 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.

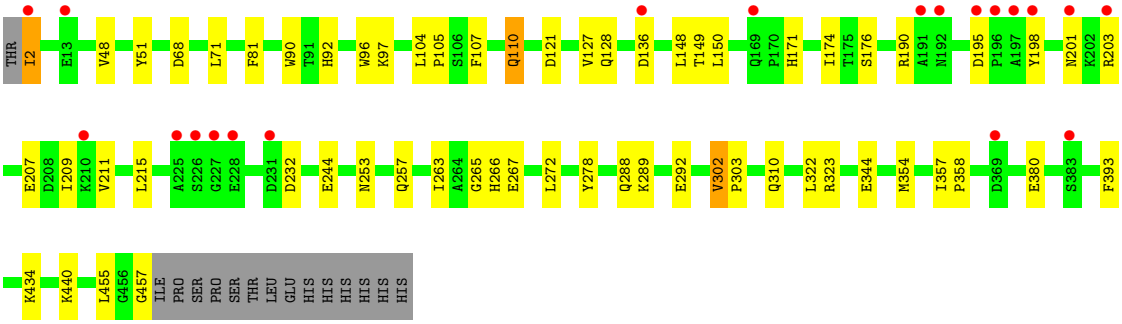
• Molecule 1: cytochrome P450 BM3 variant 2G9C6

Chain A:



• Molecule 1: cytochrome P450 BM3 variant 2G9C6

Chain B:



4 Data and refinement statistics (i)

Property	Value	Source
Space group	P 1 21 1	Depositor
Cell constants a, b, c, α, β, γ	58.73Å 153.30Å 60.98Å 90.00° 94.68° 90.00°	Depositor
Resolution (Å)	29.81 – 1.85 29.81 – 1.85	Depositor EDS
% Data completeness (in resolution range)	97.4 (29.81-1.85) 97.4 (29.81-1.85)	Depositor EDS
R_{merge}	(Not available)	Depositor
R_{sym}	0.07	Depositor
$< I/\sigma(I) >$ [1]	2.08 (at 1.85Å)	Xtriage
Refinement program	REFMAC 5.5.0109	Depositor
R, R_{free}	0.166 , 0.208 0.168 , 0.209	Depositor DCC
R_{free} test set	4428 reflections (4.98%)	wwPDB-VP
Wilson B-factor (Å^2)	24.4	Xtriage
Anisotropy	0.048	Xtriage
Bulk solvent k_{sol}(e/Å^3), B_{sol}(Å^2)	0.36 , 52.6	EDS
L-test for twinning[2]	$< \|L\| > = 0.48$, $< L^2 > = 0.31$	Xtriage
Estimated twinning fraction	0.027 for l,-k,h	Xtriage
F_o,F_c correlation	0.97	EDS
Total number of atoms	8137	wwPDB-VP
Average B, all atoms (Å^2)	28.0	wwPDB-VP

Xtriage's analysis on translational NCS is as follows: *The largest off-origin peak in the Patterson function is 4.69% of the height of the origin peak. No significant pseudotranslation is detected.*

[1]Intensities estimated from amplitudes.

[2]Theoretical values of $< |L| >$, $< L^2 >$ 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: 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	1.13	9/3830 (0.2%)	0.97	6/5180 (0.1%)
1	B	1.11	6/3841 (0.2%)	0.97	8/5192 (0.2%)
All	All	1.12	15/7671 (0.2%)	0.97	14/10372 (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	B	0	1

All (15) bond length outliers are listed below:

Mol	Chain	Res	Type	Atoms	Z	Observed(Å)	Ideal(Å)
1	B	90	TRP	CE3-CZ3	7.28	1.50	1.38
1	B	393	PHE	CE1-CZ	7.20	1.51	1.37
1	A	50[A]	CYS	CB-SG	-7.18	1.70	1.82
1	A	50[B]	CYS	CB-SG	-7.18	1.70	1.82
1	A	390	PHE	CE1-CZ	6.92	1.50	1.37
1	B	107	PHE	CE2-CZ	6.48	1.49	1.37
1	B	380	GLU	CG-CD	6.32	1.61	1.51
1	A	330	ALA	CA-CB	6.07	1.65	1.52
1	A	393	PHE	CE2-CZ	6.06	1.48	1.37
1	A	289	LYS	CE-NZ	5.36	1.62	1.49
1	A	143	GLU	CG-CD	5.26	1.59	1.51
1	B	278	TYR	CG-CD1	5.15	1.45	1.39
1	A	293	GLU	CD-OE2	5.14	1.31	1.25
1	B	244	GLU	CB-CG	5.08	1.61	1.52
1	A	398	ARG	CG-CD	5.01	1.64	1.51

All (14) bond angle outliers are listed below:

Mol	Chain	Res	Type	Atoms	Z	Observed(^{o})	Ideal(^{o})
1	A	323	ARG	NE-CZ-NH2	-7.78	116.41	120.30
1	B	68	ASP	CB-CG-OD2	-6.28	112.65	118.30
1	B	71	LEU	CB-CG-CD2	-5.74	101.25	111.00
1	B	121	ASP	CB-CG-OD2	5.71	123.44	118.30
1	A	68	ASP	CB-CG-OD2	-5.68	113.19	118.30
1	B	232	ASP	CB-CG-OD1	5.38	123.15	118.30
1	A	104	LEU	CB-CG-CD1	-5.38	101.86	111.00
1	A	362	ARG	NE-CZ-NH2	-5.18	117.71	120.30
1	B	323	ARG	NE-CZ-NH2	-5.18	117.71	120.30
1	B	68	ASP	CB-CG-OD1	5.14	122.92	118.30
1	B	323	ARG	NE-CZ-NH1	5.12	122.86	120.30
1	B	96	TRP	CA-CB-CG	-5.09	104.03	113.70
1	A	369	ASP	CB-CG-OD1	5.08	122.87	118.30
1	A	398	ARG	NE-CZ-NH1	-5.06	117.77	120.30

There are no chirality outliers.

All (1) planarity outliers are listed below:

Mol	Chain	Res	Type	Group
1	B	136	ASP	Peptide

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	3743	0	3674	40	0
1	B	3746	0	3693	43	0
2	A	43	0	30	1	0
2	B	43	0	30	1	0
3	A	289	0	0	0	0
3	B	273	0	0	3	0
All	All	8137	0	7427	83	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 6.

All (83) 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:B:150[B]:LEU:HD21	1:B:174:ILE:HD11	1.31	1.08
1:B:150[B]:LEU:HD21	1:B:174:ILE:CD1	1.98	0.94
1:A:268:SER:HA	1:A:327[B]:THR:HG21	1.52	0.92
1:A:277[B]:LEU:HD11	1:A:417:MET:CE	2.06	0.85
1:B:266[A]:HIS:NE2	1:B:267:GLU:HG2	1.91	0.84
1:B:207:GLU:O	1:B:211:VAL:HG23	1.77	0.84
1:A:268:SER:HA	1:A:327[B]:THR:CG2	2.08	0.83
1:A:277[B]:LEU:HD21	1:A:417:MET:HE1	1.62	0.81
1:A:277[B]:LEU:HD11	1:A:417:MET:HE3	1.63	0.80
1:B:92[A]:HIS:CD2	1:B:92[A]:HIS:H	2.05	0.74
1:B:2:ILE:CG2	1:B:344:GLU:HG2	2.19	0.72
1:A:277[B]:LEU:HD21	1:A:417:MET:CE	2.23	0.69
1:A:370:ASP:OD2	1:A:375:ARG:NH2	2.24	0.68
1:B:266[A]:HIS:CD2	1:B:267:GLU:HG2	2.28	0.68
1:A:277[B]:LEU:CD1	1:A:417:MET:HE3	2.23	0.67
1:A:267:GLU:HB3	1:A:438:LEU:HD13	1.77	0.65
1:B:150[B]:LEU:CD2	1:B:174:ILE:CD1	2.72	0.65
1:A:150:LEU:HD13	1:A:174:ILE:HD13	1.80	0.64
1:A:81:PHE:HB3	1:A:209:ILE:HG12	1.78	0.64
1:B:266[A]:HIS:CE1	1:B:267:GLU:HG2	2.32	0.64
1:A:268:SER:CA	1:A:327[B]:THR:HG21	2.27	0.64
1:B:266[A]:HIS:CG	1:B:267:GLU:N	2.69	0.60
1:B:2:ILE:HG22	1:B:344:GLU:HG2	1.82	0.60
1:A:201:ASN:H	1:A:201:ASN:HD22	1.49	0.60
1:A:38:GLU:HB2	1:A:54:SER:HB3	1.85	0.58
1:A:268:SER:O	1:A:327[A]:THR:HG21	2.04	0.57
1:B:127:VAL:HG12	1:B:455:LEU:HD22	1.84	0.57
1:A:277[B]:LEU:CD1	1:A:417:MET:CE	2.82	0.56
1:B:171:HIS:HB3	1:B:174:ILE:HD12	1.87	0.56
1:B:127:VAL:CG1	1:B:455:LEU:HD22	2.37	0.54
1:B:110:GLN:HB2	3:B:866:HOH:O	2.08	0.54
1:B:81:PHE:CE2	1:B:263:ILE:HD11	2.43	0.53
1:B:149:THR:OG1	1:B:266[B]:HIS:HD2	1.91	0.53
1:B:104:LEU:N	1:B:105:PRO:HD2	2.23	0.53
1:B:150[B]:LEU:CD2	1:B:174:ILE:HD13	2.39	0.52
1:A:81:PHE:CE2	1:A:263:ILE:HD11	2.45	0.52
1:A:158:PHE:CE1	1:A:219:ILE:HD13	2.45	0.52
1:B:97:LYS:HB2	3:B:826:HOH:O	2.09	0.52
1:B:211:VAL:O	1:B:215:LEU:HG	2.09	0.51
1:A:47:ARG:HH11	1:A:47:ARG:HG3	1.74	0.51
1:A:81:PHE:HE2	1:A:263:ILE:HD11	1.76	0.50

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Atom-1	Atom-2	Interatomic distance (Å)	Clash overlap (Å)
1:A:287:LEU:HD12	1:A:287:LEU:O	2.11	0.50
1:A:141:VAL:O	1:A:145:MET:HG2	2.12	0.50
1:A:431:LEU:HD21	1:A:433:ILE:HD11	1.93	0.49
1:A:277[B]:LEU:HD11	1:A:417:MET:HE1	1.88	0.49
1:A:158:PHE:HE1	1:A:219:ILE:HD13	1.77	0.48
1:A:191:ALA:O	1:A:193:PRO:HD3	2.14	0.48
1:B:92[A]:HIS:CD2	1:B:92[A]:HIS:N	2.79	0.48
1:A:301:PRO:HB2	1:A:456:GLY:HA3	1.95	0.47
1:A:277[B]:LEU:CD2	1:A:417:MET:HE1	2.41	0.47
1:B:128[B]:GLN:OE1	1:B:128[B]:GLN:HA	2.13	0.47
1:A:316:MET:CE	1:A:377:GLU:HA	2.45	0.47
2:A:500:HEM:HMC2	2:A:500:HEM:HBC2	1.97	0.47
1:B:81:PHE:HE2	1:B:263:ILE:HD11	1.80	0.46
1:B:104:LEU:N	1:B:105:PRO:CD	2.78	0.46
1:B:434:LYS:HD3	1:B:440:LYS:HE3	1.96	0.46
1:B:288:GLN:O	1:B:292:GLU:HG3	2.15	0.46
1:B:310[B]:GLN:HG2	3:B:648:HOH:O	2.15	0.46
1:A:277[B]:LEU:CD2	1:A:417:MET:CE	2.94	0.45
1:A:457:GLY:HA2	1:B:457:GLY:O	2.17	0.44
1:A:38:GLU:HB2	1:A:54:SER:CB	2.47	0.44
1:B:51:TYR:CE2	1:B:354:MET:HG2	2.52	0.44
1:B:198:TYR:HA	1:B:201:ASN:OD1	2.18	0.44
1:B:253:ASN:O	1:B:257:GLN:HG2	2.19	0.43
1:B:81:PHE:HB3	1:B:209:ILE:HG12	1.99	0.43
1:A:326:PRO:HG3	1:A:357:ILE:HG22	1.99	0.43
1:A:109:GLN:HE22	1:A:309:LYS:NZ	2.17	0.43
1:B:265:GLY:HA2	2:B:500:HEM:C2C	2.54	0.43
1:B:289[B]:LYS:HE2	1:B:289[B]:LYS:HB2	1.40	0.42
1:A:60:GLU:OE2	1:A:342:GLY:HA2	2.19	0.42
1:A:38:GLU:CB	1:A:54:SER:HB3	2.48	0.42
1:B:110:GLN:O	1:B:110:GLN:HG3	2.19	0.42
1:A:59:LYS:CG	1:A:387:GLN:HE21	2.31	0.42
1:B:195:ASP:HB3	1:B:198:TYR:CD2	2.55	0.42
1:A:367:TRP:HB2	1:A:371:VAL:HG12	2.02	0.42
1:B:272:LEU:HD13	1:B:322:LEU:HG	2.02	0.41
1:A:158:PHE:HD1	1:A:219:ILE:HG21	1.86	0.41
1:B:302:VAL:HA	1:B:303:PRO:HD3	1.88	0.41
1:B:357:ILE:N	1:B:358:PRO:CD	2.83	0.41
1:A:268:SER:O	1:A:327[B]:THR:HG21	2.20	0.41
1:B:92[B]:HIS:CD2	1:B:92[B]:HIS:N	2.89	0.41
1:B:2:ILE:HG21	1:B:344:GLU:HG2	1.99	0.40

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	466/471 (99%)	454 (97%)	12 (3%)	0	100	100
1	B	467/471 (99%)	455 (97%)	12 (3%)	0	100	100
All	All	933/942 (99%)	909 (97%)	24 (3%)	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	405/413 (98%)	401 (99%)	4 (1%)	76	69
1	B	404/413 (98%)	396 (98%)	8 (2%)	55	40
All	All	809/826 (98%)	797 (98%)	12 (2%)	65	53

All (12) residues with a non-rotameric sidechain are listed below:

Mol	Chain	Res	Type
1	A	148	LEU
1	A	158	PHE
1	A	194	ASP
1	A	287	LEU
1	B	2	ILE

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Mol	Chain	Res	Type
1	B	48	VAL
1	B	110	GLN
1	B	148	LEU
1	B	176	SER
1	B	190	ARG
1	B	203	ARG
1	B	302	VAL

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

Mol	Chain	Res	Type
1	A	109	GLN
1	A	201	ASN
1	A	387	GLN
1	A	437	GLN
1	B	109	GLN

5.3.3 RNA (i)

There are no RNA molecules in this entry.

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

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

5.5 Carbohydrates (i)

There are no monosaccharides in this entry.

5.6 Ligand geometry (i)

2 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	A	500	1,3	41,50,50	1.86	10 (24%)	45,82,82	2.34	15 (33%)
2	HEM	B	500	1,3	41,50,50	1.88	9 (21%)	45,82,82	2.23	13 (28%)

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	A	500	1,3	-	2/12/54/54	-
2	HEM	B	500	1,3	-	2/12/54/54	-

All (19) bond length outliers are listed below:

Mol	Chain	Res	Type	Atoms	Z	Observed(Å)	Ideal(Å)
2	B	500	HEM	C3D-C2D	6.72	1.51	1.36
2	A	500	HEM	C3D-C2D	5.99	1.49	1.36
2	B	500	HEM	C3C-C2C	-4.31	1.34	1.40
2	A	500	HEM	FE-ND	3.63	2.14	1.96
2	B	500	HEM	FE-ND	3.57	2.14	1.96
2	A	500	HEM	C3C-C2C	-3.27	1.35	1.40
2	A	500	HEM	C1B-NB	-2.82	1.35	1.40
2	A	500	HEM	FE-NB	2.74	2.10	1.96
2	B	500	HEM	CBD-CGD	2.47	1.56	1.50
2	B	500	HEM	C4A-NA	2.45	1.41	1.36
2	A	500	HEM	CBD-CGD	2.38	1.56	1.50
2	B	500	HEM	O1D-CGD	2.37	1.30	1.22
2	B	500	HEM	CMC-C2C	2.36	1.57	1.51
2	A	500	HEM	C3C-CAC	2.28	1.52	1.47
2	A	500	HEM	O1A-CGA	2.26	1.29	1.22
2	B	500	HEM	CMA-C3A	2.26	1.56	1.51
2	B	500	HEM	FE-NB	2.15	2.07	1.96
2	A	500	HEM	CAB-C3B	2.14	1.53	1.47
2	A	500	HEM	CBA-CGA	2.12	1.55	1.50

All (28) bond angle outliers are listed below:

Mol	Chain	Res	Type	Atoms	Z	Observed(^{o})	Ideal(^{o})
2	B	500	HEM	C4D-ND-C1D	7.55	112.87	105.07
2	A	500	HEM	C4D-ND-C1D	7.33	112.64	105.07
2	A	500	HEM	C1B-NB-C4B	5.70	110.96	105.07

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Mol	Chain	Res	Type	Atoms	Z	Observed(^{o})	Ideal(^{o})
2	B	500	HEM	C1B-NB-C4B	5.28	110.53	105.07
2	B	500	HEM	CBA-CAA-C2A	-4.93	104.21	112.62
2	A	500	HEM	CHC-C4B-NB	4.34	129.14	124.43
2	A	500	HEM	CBD-CAD-C3D	-4.21	100.93	112.63
2	A	500	HEM	C2C-C3C-C4C	3.95	109.66	106.90
2	B	500	HEM	C4C-CHD-C1D	3.74	127.49	122.56
2	A	500	HEM	C4C-CHD-C1D	3.51	127.19	122.56
2	B	500	HEM	CBD-CAD-C3D	-3.10	104.01	112.63
2	A	500	HEM	CHA-C4D-ND	3.09	128.19	124.38
2	A	500	HEM	CBA-CAA-C2A	-2.91	107.66	112.62
2	B	500	HEM	CAD-C3D-C4D	2.89	129.71	124.66
2	B	500	HEM	C2B-C1B-NB	-2.78	106.55	109.84
2	B	500	HEM	CHB-C1B-NB	2.70	127.72	124.38
2	A	500	HEM	O2A-CGA-CBA	2.70	122.71	114.03
2	B	500	HEM	CHC-C4B-NB	2.47	127.12	124.43
2	B	500	HEM	CMA-C3A-C4A	-2.46	124.68	128.46
2	B	500	HEM	C3D-C4D-ND	-2.44	107.45	110.17
2	A	500	HEM	C3D-C4D-ND	-2.40	107.50	110.17
2	B	500	HEM	CAD-C3D-C2D	-2.21	123.77	127.88
2	B	500	HEM	C4B-CHC-C1C	2.18	125.43	122.56
2	A	500	HEM	CMA-C3A-C4A	-2.17	125.13	128.46
2	A	500	HEM	C2B-C1B-NB	-2.08	107.38	109.84
2	A	500	HEM	O2D-CGD-CBD	2.07	120.67	114.03
2	A	500	HEM	CAD-CBD-CGD	-2.06	109.18	113.60
2	A	500	HEM	CHB-C1B-NB	2.01	126.86	124.38

There are no chirality outliers.

All (4) torsion outliers are listed below:

Mol	Chain	Res	Type	Atoms
2	B	500	HEM	CAD-CBD-CGD-O1D
2	B	500	HEM	CAD-CBD-CGD-O2D
2	A	500	HEM	CAD-CBD-CGD-O2D
2	A	500	HEM	CAA-CBA-CGA-O2A

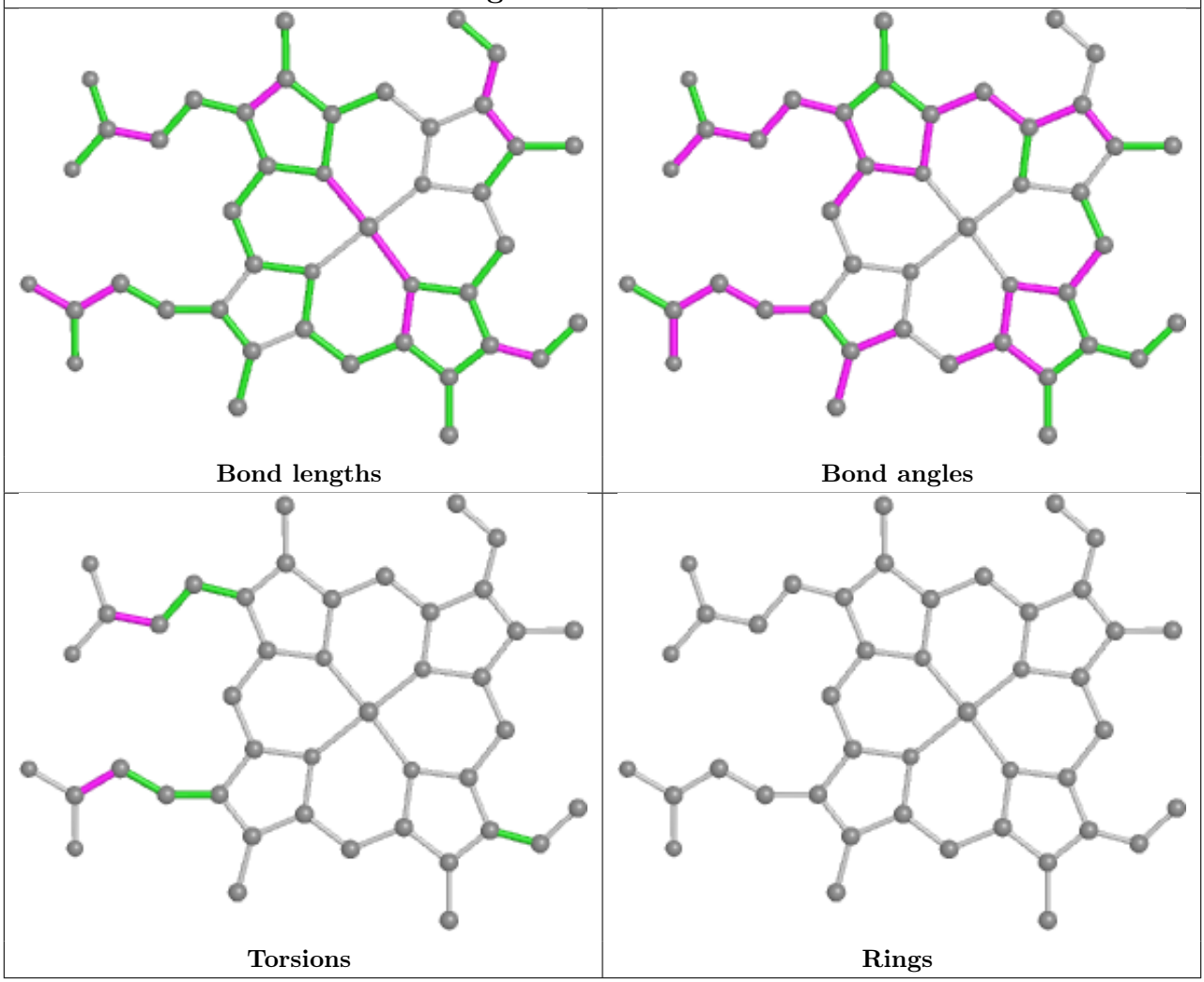
There are no ring outliers.

2 monomers are involved in 2 short contacts:

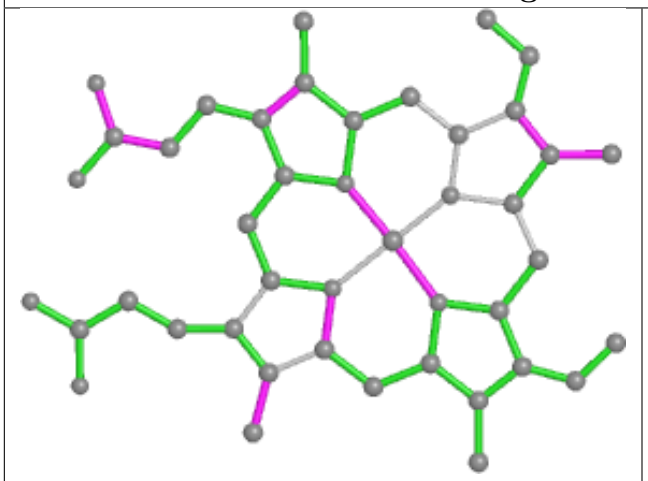
Mol	Chain	Res	Type	Clashes	Symm-Clashes
2	A	500	HEM	1	0
2	B	500	HEM	1	0

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 then 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.

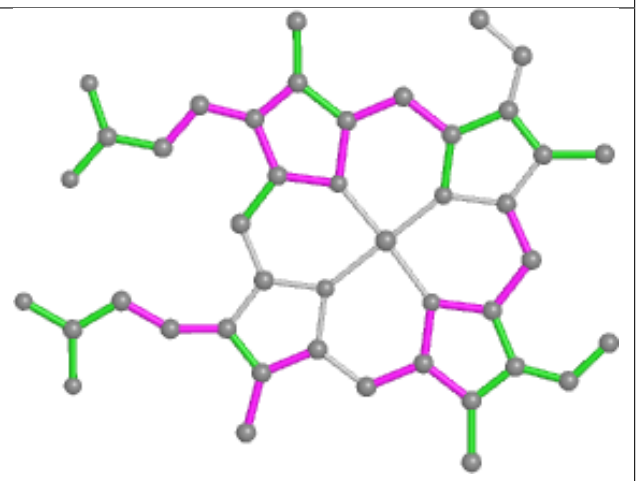
Ligand HEM A 500



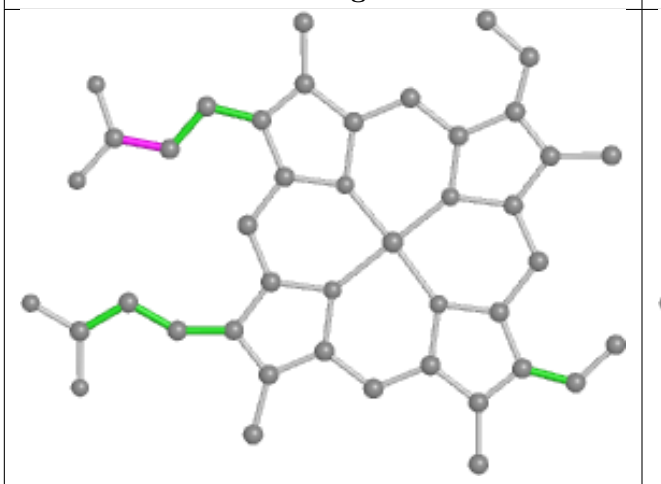
Ligand HEM B 500



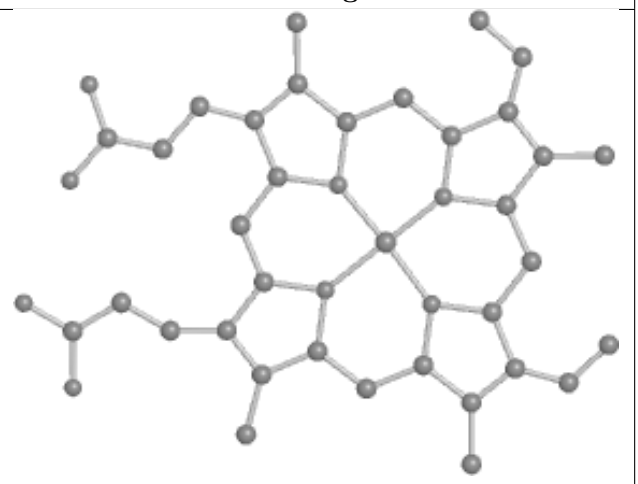
Bond lengths



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 (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	456/471 (96%)	-0.19	12 (2%)	56	54	13, 26, 46, 65	0
1	B	456/471 (96%)	-0.01	20 (4%)	34	33	13, 26, 50, 77	0
All	All	912/942 (96%)	-0.10	32 (3%)	44	41	13, 26, 48, 77	0

All (32) RSRZ outliers are listed below:

Mol	Chain	Res	Type	RSRZ
1	B	2	ILE	5.9
1	B	191	ALA	5.4
1	A	196	PRO	5.3
1	A	191	ALA	5.1
1	B	197	ALA	4.8
1	A	192	ASN	4.7
1	B	192	ASN	4.5
1	B	225	ALA	3.8
1	A	2	ILE	3.5
1	B	203	ARG	3.3
1	B	201	ASN	3.3
1	A	197	ALA	3.2
1	B	198	TYR	3.0
1	A	195	ASP	2.9
1	B	228	GLU	2.8
1	A	199	ASP	2.8
1	B	369	ASP	2.7
1	B	136	ASP	2.7
1	B	195	ASP	2.6
1	A	194	ASP	2.5
1	B	13	GLU	2.4
1	B	383	SER	2.4
1	B	227	GLY	2.2
1	B	169	GLN	2.2

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Mol	Chain	Res	Type	RSRZ
1	B	196	PRO	2.2
1	B	231	ASP	2.2
1	A	231	ASP	2.2
1	A	457	GLY	2.1
1	A	46	GLY	2.0
1	B	226	SER	2.0
1	A	198	TYR	2.0
1	B	210	LYS	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 monosaccharides in this entry.

6.4 Ligands (i)

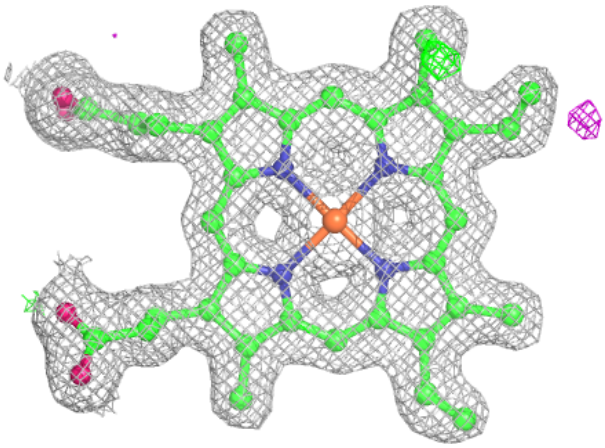
In the following table, the Atoms column lists the number of modelled atoms in the group and the number defined in the chemical component dictionary. The B-factors column lists the minimum, median, 95th percentile and maximum values of B factors of atoms in the group. The column labelled 'Q< 0.9' lists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

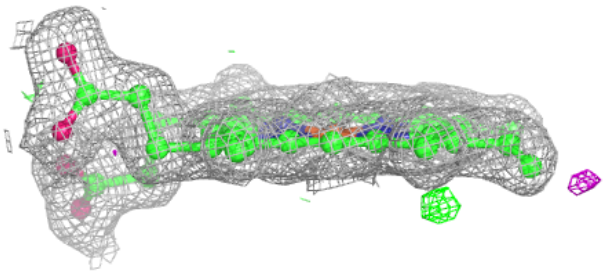
Mol	Type	Chain	Res	Atoms	RSCC	RSR	B-factors(Å^2)	Q<0.9
2	HEM	A	500	43/43	0.99	0.11	9,14,19,25	0
2	HEM	B	500	43/43	0.99	0.13	8,14,17,25	0

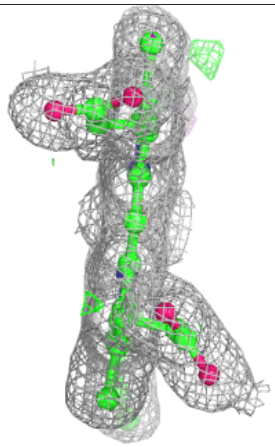
The following is a graphical depiction of the model fit to experimental electron density of all instances of the Ligand of Interest. In addition, ligands with molecular weight > 250 and outliers as shown on the geometry validation Tables will also be included. Each fit is shown from different orientation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

Electron density around HEM A 500:

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

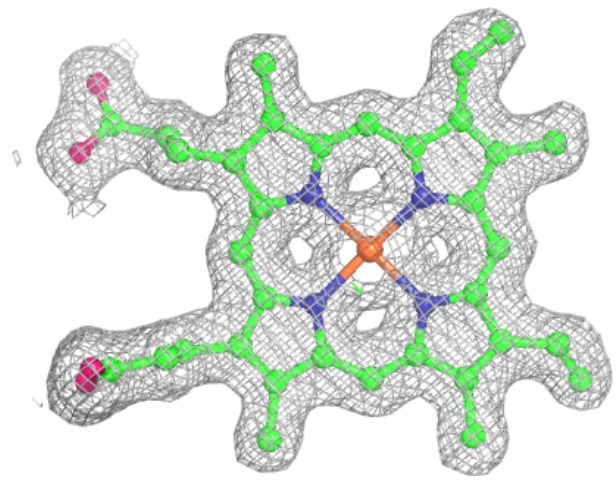


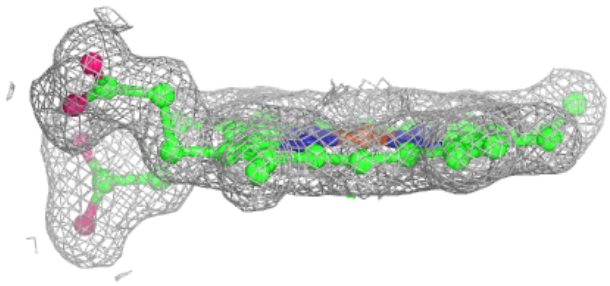


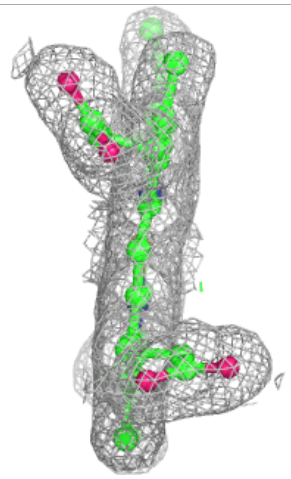


Electron density around HEM B 500:

2mF$_o$-DF$_c$ (at 0.7 rmsd) in gray
mF$_o$-DF$_c$ (at 3 rmsd) in purple (negative)
and green (positive)







6.5 Other polymers (i)

There are no such residues in this entry.