wwPDB X-ray Structure Validation Summary Report (i)

Feb 1, 2016 – 06:07 PM GMT

PDB ID	:	4KMM
Title	:	M76H variant of human ferrochelatase
Authors	:	Lanzilotta, W.N.; Medlock, A.E.
Deposited on	:	2013-05-08
Resolution	:	2.60 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
http://wwpdb.org/validation/2016/XrayValidationReportHelp
with specific help available everywhere you see the (i) symbol.

The following versions of software and data (see references (1)) were used in the production of this report:

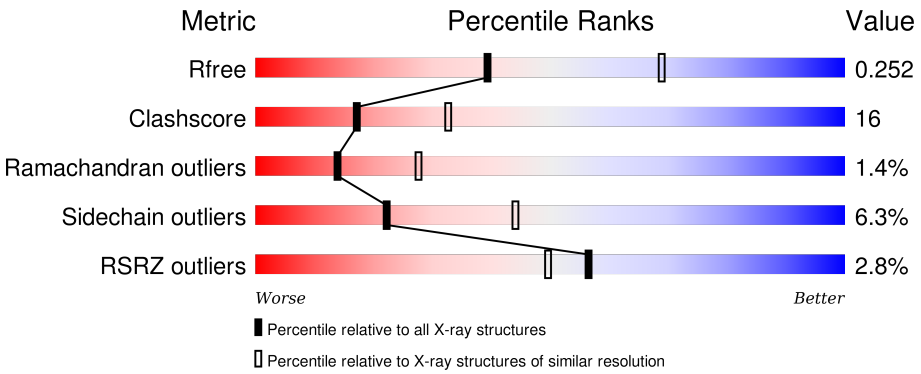
MolProbity	:	4.02b-467
Mogul	:	1.7 (RC4), CSD as536be (2015)
Xtriage (Phenix)	:	1.9-1692
EDS	:	rb-20026688
Percentile statistics	:	20151230.v01 (using entries in the PDB archive December 30th 2015)
Refmac	:	5.8.0135
CCP4	:	6.5.0
Ideal geometry (proteins)	:	Engh & Huber (2001)
Ideal geometry (DNA, RNA)	:	Parkinson et al. (1996)
Validation Pipeline (wwPDB-VP)	:	trunk26865

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 2.60 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}	91344	2328 (2.60-2.60)
Clashscore	102246	2679 (2.60-2.60)
Ramachandran outliers	100387	2635 (2.60-2.60)
Sidechain outliers	100360	2635 (2.60-2.60)
RSRZ outliers	91569	2334 (2.60-2.60)

The table below summarises the geometric issues observed across the polymeric chains and their fit to the electron density. The red, orange, yellow and green segments on the lower bar indicate the fraction of residues that contain outliers for >=3, 2, 1 and 0 types of geometric quality criteria. 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	370	2% 76% 18% • •
1	B	370	3% 69% 23% 5% •

The following table lists non-polymeric compounds, carbohydrate monomers and non-standard residues in protein, DNA, RNA chains that are outliers for geometric or electron-density-fit criteria:

Mol	Type	Chain	Res	Chirality	Geometry	Clashes	Electron density
2	HEM	A	501	-	-	-	X
2	HEM	B	501	-	-	-	X
4	CHD	A	503	-	-	-	X
4	CHD	A	504	-	-	-	X
4	CHD	B	503	-	-	-	X
4	CHD	B	504	-	-	-	X

2 Entry composition (i)

There are 6 unique types of molecules in this entry. The entry contains 6127 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.

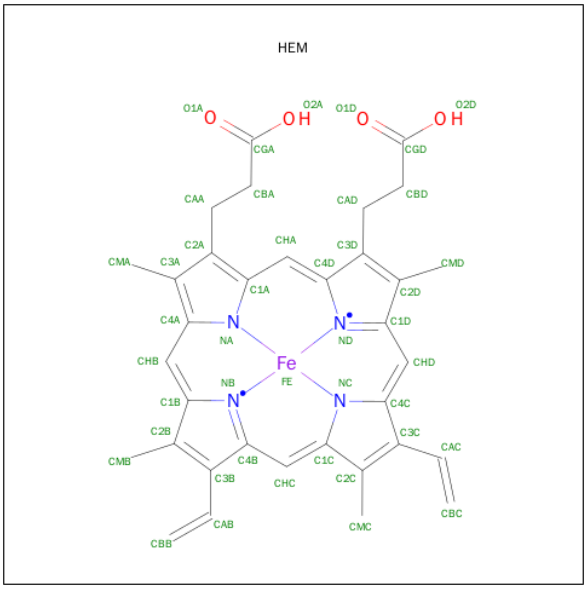
- Molecule 1 is a protein called Ferrochelatase, mitochondrial.

Mol	Chain	Residues	Atoms					ZeroOcc	AltConf	Trace
			Total	C	N	O	S			
1	A	359	2903	1848	508	530	17	0	1	0
1	B	359	2903	1848	508	530	17	0	1	0

There are 24 discrepancies between the modelled and reference sequences:

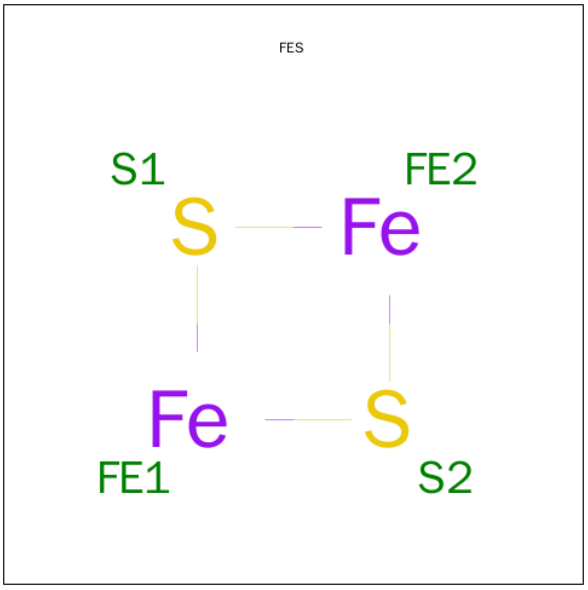
Chain	Residue	Modelled	Actual	Comment	Reference
A	54	MET	-	EXPRESSION TAG	UNP P22830
A	55	GLY	-	EXPRESSION TAG	UNP P22830
A	56	GLY	-	EXPRESSION TAG	UNP P22830
A	57	SER	-	EXPRESSION TAG	UNP P22830
A	58	HIS	-	EXPRESSION TAG	UNP P22830
A	59	HIS	-	EXPRESSION TAG	UNP P22830
A	60	HIS	-	EXPRESSION TAG	UNP P22830
A	61	HIS	-	EXPRESSION TAG	UNP P22830
A	62	HIS	-	EXPRESSION TAG	UNP P22830
A	63	HIS	-	EXPRESSION TAG	UNP P22830
A	64	GLY	-	EXPRESSION TAG	UNP P22830
A	76	HIS	MET	ENGINEERED MUTATION	UNP P22830
B	54	MET	-	EXPRESSION TAG	UNP P22830
B	55	GLY	-	EXPRESSION TAG	UNP P22830
B	56	GLY	-	EXPRESSION TAG	UNP P22830
B	57	SER	-	EXPRESSION TAG	UNP P22830
B	58	HIS	-	EXPRESSION TAG	UNP P22830
B	59	HIS	-	EXPRESSION TAG	UNP P22830
B	60	HIS	-	EXPRESSION TAG	UNP P22830
B	61	HIS	-	EXPRESSION TAG	UNP P22830
B	62	HIS	-	EXPRESSION TAG	UNP P22830
B	63	HIS	-	EXPRESSION TAG	UNP P22830
B	64	GLY	-	EXPRESSION TAG	UNP P22830
B	76	HIS	MET	ENGINEERED MUTATION	UNP P22830

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



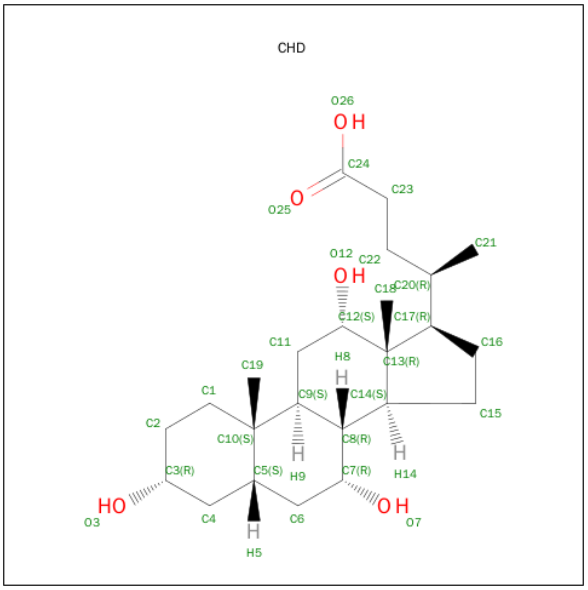
Mol	Chain	Residues	Atoms					ZeroOcc	AltConf
			Total	C	Fe	N	O		
2	A	1	43	34	1	4	4	0	0
			Total	C	Fe	N	O		
2	B	1	43	34	1	4	4	0	0

- Molecule 3 is FE2/S2 (INORGANIC) CLUSTER (three-letter code: FES) (formula: Fe_2S_2).



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

- Molecule 4 is CHOLIC ACID (three-letter code: CHD) (formula: $C_{24}H_{40}O_5$).



Mol	Chain	Residues	Atoms			ZeroOcc	AltConf
			Total	C	O		
4	A	1	29	24	5	0	0
			Total	C	O		
4	A	1	29	24	5	0	0
			Total	C	O		
4	B	1	29	24	5	0	0
			Total	C	O		
4	B	1	29	24	5	0	0

- Molecule 5 is CHLORIDE ION (three-letter code: CL) (formula: Cl).

Mol	Chain	Residues	Atoms		ZeroOcc	AltConf
			Total	Cl		
5	B	1	1	1	0	0
			Total	Cl		
5	A	1	1	1	0	0

- Molecule 6 is water.

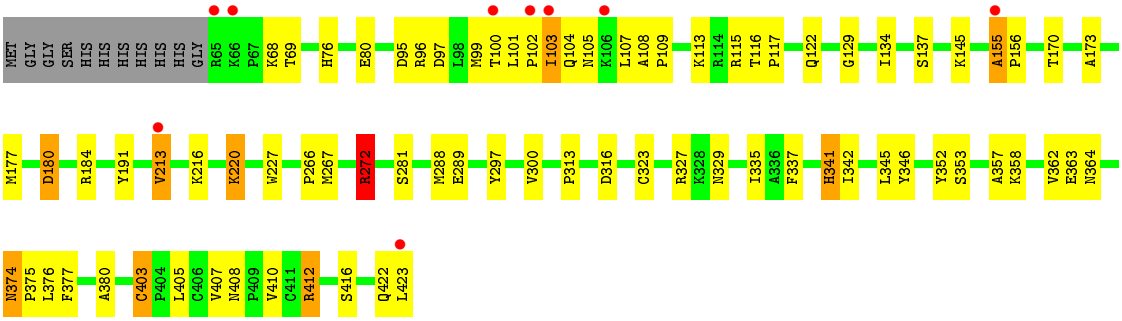
Mol	Chain	Residues	Atoms		ZeroOcc	AltConf
			Total	O		
6	A	59	59	59	0	0
			Total	O		
6	B	50	50	50	0	0

3 Residue-property plots (i)

These plots are drawn for all protein, RNA and DNA chains in the entry. The first graphic for a chain summarises the proportions of errors 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.

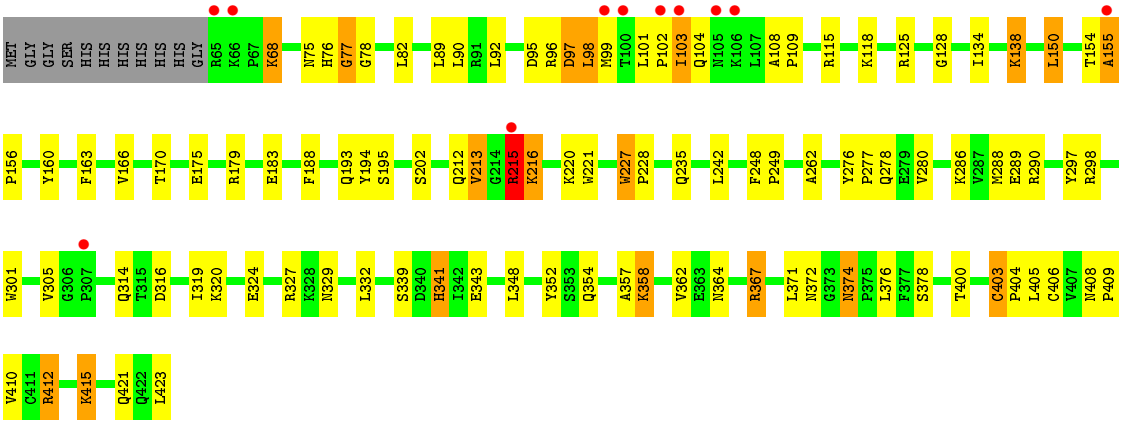
- Molecule 1: Ferrochelatase, mitochondrial

Chain A:



- Molecule 1: Ferrochelatase, mitochondrial

Chain B:



4 Data and refinement statistics (i)

Property	Value	Source
Space group	P 21 21 21	Depositor
Cell constants a, b, c, α, β, γ	88.14Å 93.42Å 110.22Å 90.00° 90.00° 90.00°	Depositor
Resolution (Å)	71.26 – 2.60 47.47 – 2.50	Depositor EDS
% Data completeness (in resolution range)	96.3 (71.26-2.60) 93.8 (47.47-2.50)	Depositor EDS
R_{merge}	(Not available)	Depositor
R_{sym}	(Not available)	Depositor
$< I/\sigma(I) >$ [1]	2.28 (at 2.51Å)	Xtriage
Refinement program	REFMAC 5.5.0102	Depositor
R, R_{free}	0.205 , 0.259 0.202 , 0.252	Depositor DCC
R_{free} test set	1400 reflections (5.34%)	DCC
Wilson B-factor (Å^2)	32.6	Xtriage
Anisotropy	0.894	Xtriage
Bulk solvent k_{sol}(e/Å^3), B_{sol}(Å^2)	0.35 , 42.7	EDS
Estimated twinning fraction	No twinning to report.	Xtriage
L-test for twinning[2]	$< \|L\| > = 0.49$, $< L^2 > = 0.32$	Xtriage
Outliers	4 of 30008 reflections (0.013%)	Xtriage
F_o,F_c correlation	0.95	EDS
Total number of atoms	6127	wwPDB-VP
Average B, all atoms (Å^2)	34.0	wwPDB-VP

Xtriage's analysis on translational NCS is as follows: *The analyses of the Patterson function reveals a significant off-origin peak that is 54.78 % of the origin peak, indicating pseudo translational symmetry.The chance of finding a peak of this or larger height randomly in a structure without pseudo translational symmetry is equal to 3.4764e-05.The detected translational NCS is most likely also responsible for the elevated intensity ratio.*

[1]Intensities estimated from amplitudes.

[2]Theoretical values of $< |L| >$, $< L^2 >$ for acentric reflections are 0.5, 0.375 respectively for untwinned datasets, and 0.333, 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, CHD, FES, CL

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	1/2975 (0.0%)	0.86	3/4031 (0.1%)
1	B	0.83	0/2975	0.86	2/4031 (0.0%)
All	All	0.83	1/5950 (0.0%)	0.86	5/8062 (0.1%)

All (1) bond length outliers are listed below:

Mol	Chain	Res	Type	Atoms	Z	Observed(Å)	Ideal(Å)
1	A	403	CYS	CB-SG	-5.27	1.73	1.81

All (5) bond angle outliers are listed below:

Mol	Chain	Res	Type	Atoms	Z	Observed(^{o})	Ideal(^{o})
1	A	272	ARG	NE-CZ-NH1	7.85	124.23	120.30
1	A	272	ARG	NE-CZ-NH2	-6.66	116.97	120.30
1	B	150	LEU	CA-CB-CG	6.14	129.42	115.30
1	B	406	CYS	N-CA-CB	5.49	120.49	110.60
1	A	345	LEU	CA-CB-CG	5.38	127.68	115.30

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	2903	0	2903	73	0
1	B	2903	0	2903	93	0
2	A	43	0	30	17	0
2	B	43	0	30	20	0
3	A	4	0	0	0	0
3	B	4	0	0	0	0
4	A	58	0	78	13	0
4	B	58	0	78	10	0
5	A	1	0	0	1	0
5	B	1	0	0	1	0
6	A	59	0	0	1	0
6	B	50	0	0	2	0
All	All	6127	0	6022	195	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 16.

The worst 5 of 195 close contacts within the same asymmetric unit are listed below, sorted by their clash magnitude.

Atom-1	Atom-2	Interatomic distance (Å)	Clash overlap (Å)
2:B:501:HEM:HBD2	2:B:501:HEM:HHA	1.36	1.08
2:A:501:HEM:CMB	2:A:501:HEM:HBB2	1.84	1.07
2:A:501:HEM:CMB	4:A:503:CHD:H192	1.88	1.02
2:A:501:HEM:HMB2	4:A:503:CHD:H192	1.40	1.01
2:A:501:HEM:CBB	2:A:501:HEM:HMB1	1.90	1.00

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	358/370 (97%)	328 (92%)	26 (7%)	4 (1%)	17 36

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Mol	Chain	Analysed	Favoured	Allowed	Outliers	Percentiles	
1	B	358/370 (97%)	331 (92%)	21 (6%)	6 (2%)	11	22
All	All	716/740 (97%)	659 (92%)	47 (7%)	10 (1%)	14	28

5 of 10 Ramachandran outliers are listed below:

Mol	Chain	Res	Type
1	A	96	ARG
1	A	155	ALA
1	B	97	ASP
1	B	155	ALA
1	B	404	PRO

5.3.2 Protein sidechains (i)

In the following table, the Percentiles column shows the percent sidechain outliers of the chain as a percentile score with respect to all X-ray entries followed by that with respect to entries of similar resolution.

The Analysed column shows the number of residues for which the sidechain conformation was analysed, and the total number of residues.

Mol	Chain	Analysed	Rotameric	Outliers	Percentiles	
1	A	325/332 (98%)	309 (95%)	16 (5%)	31	57
1	B	325/332 (98%)	300 (92%)	25 (8%)	16	31
All	All	650/664 (98%)	609 (94%)	41 (6%)	22	44

5 of 41 residues with a non-rotameric sidechain are listed below:

Mol	Chain	Res	Type
1	B	98	LEU
1	B	170	THR
1	B	403	CYS
1	B	103	ILE
1	B	138	LYS

Some sidechains can be flipped to improve hydrogen bonding and reduce clashes. 5 of 15 such sidechains are listed below:

Mol	Chain	Res	Type
1	A	354	GLN
1	A	364	ASN

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Mol	Chain	Res	Type
1	B	329	ASN
1	A	341	HIS
1	B	104	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 carbohydrates in this entry.

5.6 Ligand geometry (i)

Of 10 ligands modelled in this entry, 2 are monoatomic - leaving 8 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	$\#\|Z\| > 2$
2	HEM	A	501	-	30,50,50	2.60	9 (30%)	24,82,82	2.64	14 (58%)
3	FES	A	502	1	0,4,4	0.00	-	0,4,4	0.00	-
4	CHD	A	503	-	29,32,32	0.64	0	48,51,51	2.26	18 (37%)
4	CHD	A	504	-	29,32,32	0.51	0	48,51,51	1.68	10 (20%)
2	HEM	B	501	-	30,50,50	2.37	10 (33%)	24,82,82	2.76	14 (58%)
3	FES	B	502	1	0,4,4	0.00	-	0,4,4	0.00	-
4	CHD	B	503	-	29,32,32	0.58	0	48,51,51	1.84	10 (20%)
4	CHD	B	504	-	29,32,32	0.52	0	48,51,51	1.88	11 (22%)

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	501	-	-	0/10/54/54	0/0/8/8
3	FES	A	502	1	-	0/0/4/4	0/1/1/1
4	CHD	A	503	-	-	0/7/74/74	0/4/4/4
4	CHD	A	504	-	-	0/7/74/74	0/4/4/4
2	HEM	B	501	-	-	0/10/54/54	0/0/8/8
3	FES	B	502	1	-	0/0/4/4	0/1/1/1
4	CHD	B	503	-	-	0/7/74/74	0/4/4/4
4	CHD	B	504	-	-	0/7/74/74	0/4/4/4

The worst 5 of 19 bond length outliers are listed below:

Mol	Chain	Res	Type	Atoms	Z	Observed(Å)	Ideal(Å)
2	A	501	HEM	C3B-C4B	-7.16	1.45	1.51
2	B	501	HEM	C3B-C4B	-6.43	1.46	1.51
2	B	501	HEM	C3D-C4D	-5.77	1.44	1.51
2	A	501	HEM	C3D-C4D	-5.10	1.45	1.51
2	B	501	HEM	C2C-C1C	-3.31	1.46	1.52

The worst 5 of 77 bond angle outliers are listed below:

Mol	Chain	Res	Type	Atoms	Z	Observed(^{o})	Ideal(^{o})
4	A	503	CHD	C6-C5-C4	-5.11	105.34	111.05
2	A	501	HEM	CAA-CBA-CGA	-4.62	104.27	112.75
4	A	503	CHD	C23-C22-C20	-4.37	109.61	114.75
4	B	504	CHD	C1-C10-C9	-4.06	104.91	111.45
2	B	501	HEM	CBA-CAA-C2A	-3.92	105.50	112.53

There are no chirality outliers.

There are no torsion outliers.

There are no ring outliers.

6 monomers are involved in 53 short contacts:

Mol	Chain	Res	Type	Clashes	Symm-Clashes
2	A	501	HEM	17	0
4	A	503	CHD	11	0
4	A	504	CHD	2	0
2	B	501	HEM	20	0

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Mol	Chain	Res	Type	Clashes	Symm-Clashes
4	B	503	CHD	10	0
4	B	504	CHD	2	0

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	359/370 (97%)	-0.20	9 (2%)	61	54	13, 31, 58, 67	0
1	B	359/370 (97%)	-0.18	11 (3%)	52	45	13, 31, 58, 73	0
All	All	718/740 (97%)	-0.19	20 (2%)	56	49	13, 31, 58, 73	0

The worst 5 of 20 RSRZ outliers are listed below:

Mol	Chain	Res	Type	RSRZ
1	A	103	ILE	5.0
1	A	155	ALA	3.4
1	A	102	PRO	3.2
1	A	100	THR	3.1
1	B	100	THR	3.1

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

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

6.3 Carbohydrates (i)

There are no carbohydrates in this entry.

6.4 Ligands (i)

In the following table, the Atoms column lists the number of modelled atoms in the group and the number defined in the chemical component dictionary. LLDF column lists the quality of electron density of the group with respect to its neighbouring residues in protein, DNA or RNA chains. 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	LLDF	B-factors(Å^2)	Q<0.9
2	HEM	A	501	43/43	0.70	0.42	5.35	46,58,60,62	39
2	HEM	B	501	43/43	0.67	0.41	3.88	47,54,55,57	39
4	CHD	B	504	29/29	0.74	0.49	3.02	103,105,112,113	0
4	CHD	A	503	29/29	0.77	0.42	2.97	80,82,89,89	0
4	CHD	B	503	29/29	0.68	0.45	2.58	115,118,119,119	0
4	CHD	A	504	29/29	0.80	0.45	2.19	93,95,98,98	0
5	CL	B	505	1/1	0.96	0.18	0.46	49,49,49,49	0
5	CL	A	505	1/1	0.97	0.11	-0.96	36,36,36,36	0
3	FES	B	502	4/4	0.98	0.06	-3.57	31,37,38,40	0
3	FES	A	502	4/4	0.99	0.06	-3.69	25,30,34,35	0

6.5 Other polymers (i)

There are no such residues in this entry.