



wwPDB X-ray Structure Validation Summary Report ⓘ

Jan 15, 2018 – 04:04 PM EST

PDB ID : 5OFQ
Title : Crystal structure of substrate-free CYP109A2 from *Bacillus megaterium*
Authors : Jozwik, I.K.; Thunnissen, A.M.W.H.
Deposited on : 2017-07-11
Resolution : 2.70 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 ⓘ symbol.

The following versions of software and data (see [references ⓘ](#)) were used in the production of this report:

MolProbity : 4.02b-467
Mogul : 1.7.2 (RC1), CSD as538be (2017)
Xtriage (Phenix) : 1.9-1692
EDS : rb-20030736
Percentile statistics : 20161228.v01 (using entries in the PDB archive December 28th 2016)
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) : rb-20030736

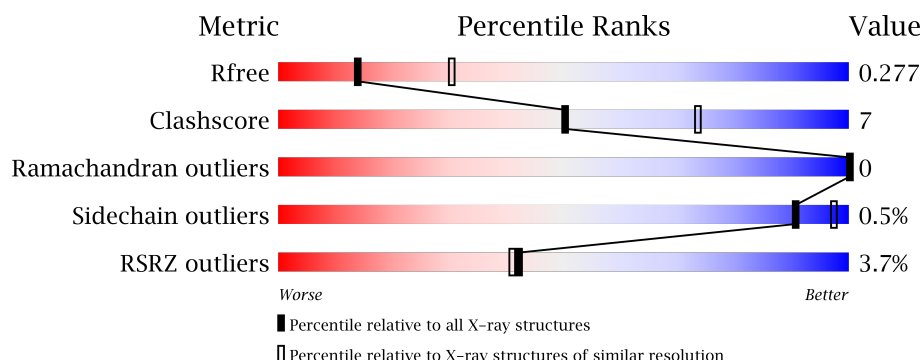
1 Overall quality at a glance

The following experimental techniques were used to determine the structure:

X-RAY DIFFRACTION

The reported resolution of this entry is 2.70 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}	100719	2259 (2.70-2.70)
Clashscore	112137	2590 (2.70-2.70)
Ramachandran outliers	110173	2550 (2.70-2.70)
Sidechain outliers	110143	2550 (2.70-2.70)
RSRZ outliers	101464	2275 (2.70-2.70)

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 $\leq 5\%$. 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	409	<div> <div>3%</div> <div>78%</div> <div>17%</div> <div>6%</div> </div>
1	B	409	<div> <div>4%</div> <div>81%</div> <div>13%</div> <div>6%</div> </div>
1	C	409	<div> <div>4%</div> <div>77%</div> <div>18%</div> <div>6%</div> </div>
1	D	409	<div> <div>3%</div> <div>77%</div> <div>17%</div> <div>5%</div> </div>

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

ria:

Mol	Type	Chain	Res	Chirality	Geometry	Clashes	Electron density
3	1PE	B	502	-	-	-	X
3	1PE	C	502	-	-	-	X

2 Entry composition

There are 5 unique types of molecules in this entry. The entry contains 12726 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.

Mol	Chain	Residues	Atoms					ZeroOcc	AltConf	Trace
1	A	386	Total	C	N	O	S	0	0	0
			3109	1985	522	590	12			
1	B	386	Total	C	N	O	S	0	0	0
			3109	1985	522	590	12			
1	C	386	Total	C	N	O	S	0	0	0
			3109	1985	522	590	12			
1	D	387	Total	C	N	O	S	0	0	0
			3117	1991	523	591	12			

There are 24 discrepancies between the modelled and reference sequences:

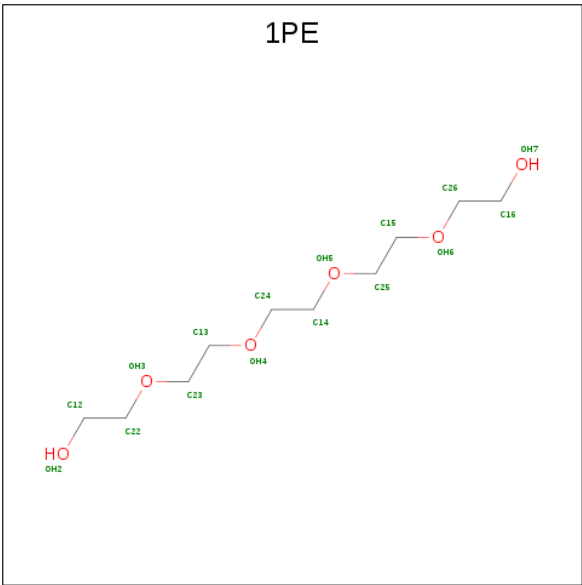
Chain	Residue	Modelled	Actual	Comment	Reference
A	404	HIS	-	expression tag	UNP D5DF88
A	405	HIS	-	expression tag	UNP D5DF88
A	406	HIS	-	expression tag	UNP D5DF88
A	407	HIS	-	expression tag	UNP D5DF88
A	408	HIS	-	expression tag	UNP D5DF88
A	409	HIS	-	expression tag	UNP D5DF88
B	404	HIS	-	expression tag	UNP D5DF88
B	405	HIS	-	expression tag	UNP D5DF88
B	406	HIS	-	expression tag	UNP D5DF88
B	407	HIS	-	expression tag	UNP D5DF88
B	408	HIS	-	expression tag	UNP D5DF88
B	409	HIS	-	expression tag	UNP D5DF88
C	404	HIS	-	expression tag	UNP D5DF88
C	405	HIS	-	expression tag	UNP D5DF88
C	406	HIS	-	expression tag	UNP D5DF88
C	407	HIS	-	expression tag	UNP D5DF88
C	408	HIS	-	expression tag	UNP D5DF88
C	409	HIS	-	expression tag	UNP D5DF88
D	404	HIS	-	expression tag	UNP D5DF88
D	405	HIS	-	expression tag	UNP D5DF88
D	406	HIS	-	expression tag	UNP D5DF88

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Chain	Residue	Modelled	Actual	Comment	Reference
D	407	HIS	-	expression tag	UNP D5DF88
D	408	HIS	-	expression tag	UNP D5DF88
D	409	HIS	-	expression tag	UNP D5DF88

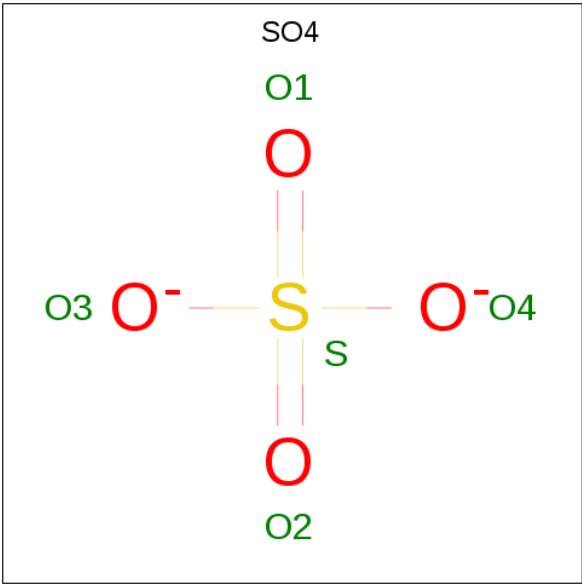
- # HEM

- Molecule 3 is PENTAETHYLENE GLYCOL (three-letter code: 1PE) (formula: $\text{C}_{10}\text{H}_{22}\text{O}_6$).



Mol	Chain	Residues	Atoms			ZeroOcc	AltConf
3	A	1	Total	C	O	0	0
			16	10	6		
3	A	1	Total	C	O	0	0
			16	10	6		
3	B	1	Total	C	O	0	0
			16	10	6		
3	C	1	Total	C	O	0	0
			16	10	6		
3	C	1	Total	C	O	0	0
			16	10	6		

- Molecule 4 is SULFATE ION (three-letter code: SO4) (formula: O₄S).



Mol	Chain	Residues	Atoms	ZeroOcc	AltConf
4	A	1	Total O S 5 4 1	0	0
4	A	1	Total O S 5 4 1	0	0
4	B	1	Total O S 5 4 1	0	0

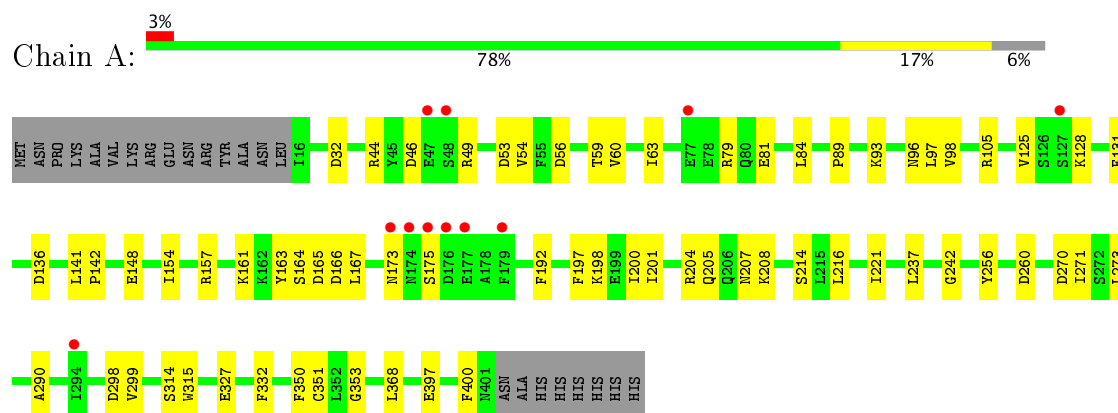
- Molecule 5 is water.

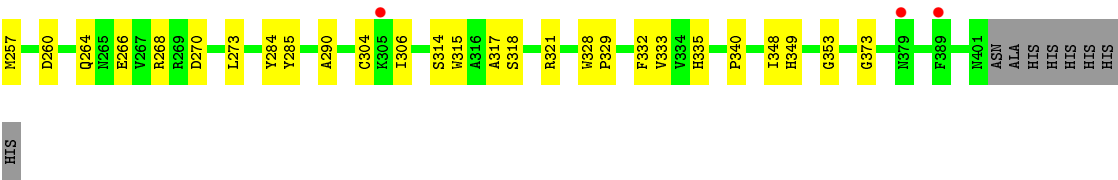
Mol	Chain	Residues	Atoms	ZeroOcc	AltConf
5	A	4	Total O 4 4	0	0
5	B	2	Total O 2 2	0	0
5	C	2	Total O 2 2	0	0
5	D	7	Total O 7 7	0	0

3 Residue-property plots [i](#)

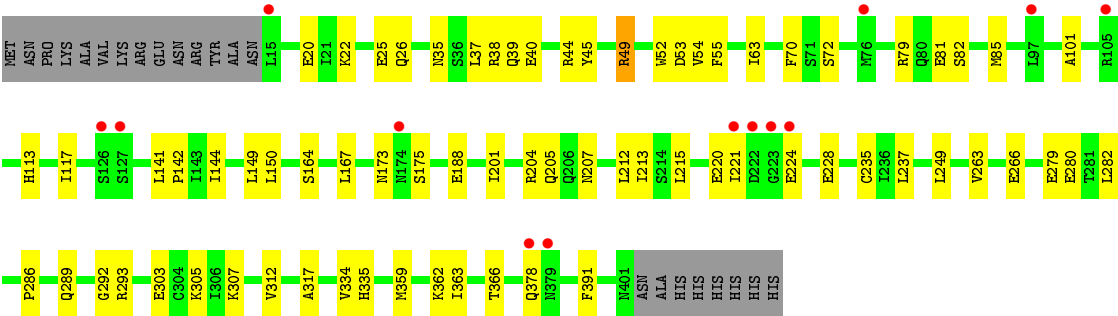
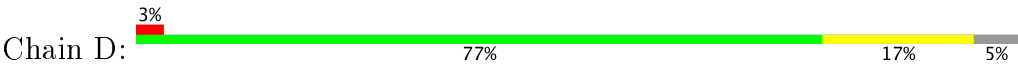
These plots are drawn for all protein, RNA and DNA chains in the entry. The first graphic for a chain summarises the proportions of the various outlier classes displayed in the second graphic. The second graphic shows the sequence view annotated by issues in geometry and electron density. Residues are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





● Molecule 1: Cytochrome P450



4 Data and refinement statistics

Property	Value	Source
Space group	P 21 21 21	Depositor
Cell constants a, b, c, α , β , γ	77.12Å 155.53Å 158.15Å 90.00° 90.00° 90.00°	Depositor
Resolution (Å)	49.93 – 2.70 49.93 – 2.70	Depositor EDS
% Data completeness (in resolution range)	97.3 (49.93-2.70) 96.7 (49.93-2.70)	Depositor EDS
R_{merge}	0.11	Depositor
R_{sym}	(Not available)	Depositor
$\langle I/\sigma(I) \rangle$ ¹	3.41 (at 2.69Å)	Xtriage
Refinement program	PHENIX 1.10.1_2155	Depositor
R, R_{free}	0.224 , 0.275 0.227 , 0.277	Depositor DCC
R_{free} test set	2612 reflections (5.09%)	DCC
Wilson B-factor (Å ²)	49.5	Xtriage
Anisotropy	0.369	Xtriage
Bulk solvent k_{sol} (e/Å ³), B_{sol} (Å ²)	0.35 , 20.8	EDS
L-test for twinning ²	$\langle L \rangle = 0.45$, $\langle L^2 \rangle = 0.27$	Xtriage
Estimated twinning fraction	0.033 for -h,l,k	Xtriage
F_o, F_c correlation	0.91	EDS
Total number of atoms	12726	wwPDB-VP
Average B, all atoms (Å ²)	45.0	wwPDB-VP

Xtriage's analysis on translational NCS is as follows: *The largest off-origin peak in the Patterson function is 11.87% of the height of the origin peak. No significant pseudotranslation is detected.*

¹Intensities estimated from amplitudes.

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

5 Model quality [i](#)

5.1 Standard geometry [i](#)

Bond lengths and bond angles in the following residue types are not validated in this section: HEM, SO4, 1PE

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	0.83	1/3172 (0.0%)	0.81	3/4286 (0.1%)
1	B	0.83	4/3172 (0.1%)	0.77	2/4286 (0.0%)
1	C	0.82	0/3172	0.77	1/4286 (0.0%)
1	D	0.78	2/3180 (0.1%)	0.76	2/4297 (0.0%)
All	All	0.82	7/12696 (0.1%)	0.78	8/17155 (0.0%)

The worst 5 of 7 bond length outliers are listed below:

Mol	Chain	Res	Type	Atoms	Z	Observed(Å)	Ideal(Å)
1	D	25	GLU	CG-CD	6.38	1.61	1.51
1	B	381	SER	CA-CB	5.68	1.61	1.52
1	B	235	CYS	CB-SG	-5.62	1.72	1.81
1	A	327	GLU	CG-CD	5.49	1.60	1.51
1	D	303	GLU	CG-CD	5.25	1.59	1.51

The worst 5 of 8 bond angle outliers are listed below:

Mol	Chain	Res	Type	Atoms	Z	Observed(°)	Ideal(°)
1	D	49	ARG	NE-CZ-NH1	7.09	123.84	120.30
1	C	157	ARG	NE-CZ-NH2	-6.60	117.00	120.30
1	D	49	ARG	NE-CZ-NH2	-6.59	117.01	120.30
1	A	136	ASP	CB-CG-OD2	5.86	123.57	118.30
1	B	49	ARG	NE-CZ-NH2	-5.81	117.40	120.30

There are no chirality outliers.

There are no planarity outliers.

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	3109	0	3092	43	0
1	B	3109	0	3092	32	0
1	C	3109	0	3092	43	1
1	D	3117	0	3103	54	1
2	A	43	0	30	3	0
2	B	43	0	30	1	0
2	C	43	0	30	1	0
2	D	43	0	30	2	0
3	A	32	0	44	2	0
3	B	16	0	22	0	0
3	C	32	0	44	4	0
4	A	10	0	0	0	0
4	B	5	0	0	0	0
5	A	4	0	0	0	0
5	B	2	0	0	0	0
5	C	2	0	0	0	0
5	D	7	0	0	0	0
All	All	12726	0	12609	168	1

The all-atom clashscore is defined as the number of clashes found per 1000 atoms (including hydrogen atoms). The all-atom clashscore for this structure is 7.

The worst 5 of 168 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:D:305:LYS:HE2	1:D:307:LYS:NZ	1.54	1.21
1:D:305:LYS:CE	1:D:307:LYS:NZ	2.04	1.19
1:D:305:LYS:HE3	1:D:307:LYS:HZ1	1.32	0.94
1:D:305:LYS:CE	1:D:307:LYS:HZ1	1.72	0.92
1:D:305:LYS:HE2	1:D:307:LYS:HZ2	1.26	0.92

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

Atom-1	Atom-2	Interatomic distance (Å)	Clash overlap (Å)
1:C:163:TYR:OH	1:D:188:GLU:OE2[2_555]	2.18	0.02

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	384/409 (94%)	371 (97%)	13 (3%)	0	100	100
1	B	384/409 (94%)	367 (96%)	17 (4%)	0	100	100
1	C	384/409 (94%)	363 (94%)	21 (6%)	0	100	100
1	D	385/409 (94%)	368 (96%)	17 (4%)	0	100	100
All	All	1537/1636 (94%)	1469 (96%)	68 (4%)	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	341/361 (94%)	339 (99%)	2 (1%)	89	97
1	B	341/361 (94%)	340 (100%)	1 (0%)	94	98
1	C	341/361 (94%)	340 (100%)	1 (0%)	94	98
1	D	342/361 (95%)	339 (99%)	3 (1%)	82	94
All	All	1365/1444 (94%)	1358 (100%)	7 (0%)	91	97

5 of 7 residues with a non-rotameric sidechain are listed below:

Mol	Chain	Res	Type
1	C	44	ARG
1	D	113	HIS
1	D	39	GLN
1	A	148	GLU
1	D	44	ARG

Some sidechains can be flipped to improve hydrogen bonding and reduce clashes. There are no such sidechains identified.

5.3.3 RNA ⓘ

There are no RNA molecules in this entry.

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

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

5.5 Carbohydrates ⓘ

There are no carbohydrates in this entry.

5.6 Ligand geometry ⓘ

12 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	501	1	28,50,50	2.20	6 (21%)	17,82,82	1.29	3 (17%)
3	1PE	A	502	-	15,15,15	0.61	0	14,14,14	0.70	0
3	1PE	A	503	-	15,15,15	0.55	0	14,14,14	0.74	0
4	SO4	A	504	-	4,4,4	0.19	0	6,6,6	0.77	0
4	SO4	A	505	-	4,4,4	0.15	0	6,6,6	0.44	0
2	HEM	B	501	1	28,50,50	1.98	6 (21%)	17,82,82	1.42	3 (17%)

Mol	Type	Chain	Res	Link	Bond lengths			Bond angles		
					Counts	RMSZ	# Z > 2	Counts	RMSZ	# Z > 2
3	1PE	B	502	-	15,15,15	0.69	0	14,14,14	0.72	0
4	SO4	B	503	-	4,4,4	0.09	0	6,6,6	0.28	0
3	1PE	C	501	-	15,15,15	0.73	0	14,14,14	1.14	1 (7%)
3	1PE	C	502	-	15,15,15	0.65	0	14,14,14	0.73	0
2	HEM	C	503	1	28,50,50	1.89	5 (17%)	17,82,82	1.57	4 (23%)
2	HEM	D	501	1	28,50,50	2.03	5 (17%)	17,82,82	1.77	3 (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	A	501	1	-	0/6/54/54	0/0/8/8
3	1PE	A	502	-	-	0/13/13/13	0/0/0/0
3	1PE	A	503	-	-	0/13/13/13	0/0/0/0
4	SO4	A	504	-	-	0/0/0/0	0/0/0/0
4	SO4	A	505	-	-	0/0/0/0	0/0/0/0
2	HEM	B	501	1	-	0/6/54/54	0/0/8/8
3	1PE	B	502	-	-	0/13/13/13	0/0/0/0
4	SO4	B	503	-	-	0/0/0/0	0/0/0/0
3	1PE	C	501	-	-	0/13/13/13	0/0/0/0
3	1PE	C	502	-	-	0/13/13/13	0/0/0/0
2	HEM	C	503	1	-	0/6/54/54	0/0/8/8
2	HEM	D	501	1	-	0/6/54/54	0/0/8/8

The worst 5 of 22 bond length outliers are listed below:

Mol	Chain	Res	Type	Atoms	Z	Observed(Å)	Ideal(Å)
2	A	501	HEM	C3C-C2C	-6.79	1.31	1.40
2	B	501	HEM	C3C-C2C	-6.41	1.31	1.40
2	A	501	HEM	C3B-C2B	-5.64	1.32	1.40
2	D	501	HEM	C3C-C2C	-5.46	1.33	1.40
2	D	501	HEM	C3B-C2B	-5.35	1.33	1.40

The worst 5 of 14 bond angle outliers are listed below:

Mol	Chain	Res	Type	Atoms	Z	Observed(°)	Ideal(°)
2	D	501	HEM	CMA-C3A-C4A	-3.53	123.04	128.46
2	D	501	HEM	CBD-CAD-C3D	-3.26	106.25	112.47
2	A	501	HEM	CAD-CBD-CGD	-2.57	108.27	112.66

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Mol	Chain	Res	Type	Atoms	Z	Observed(°)	Ideal(°)
2	B	501	HEM	CAA-CBA-CGA	-2.40	108.56	112.66
2	C	503	HEM	CMA-C3A-C4A	-2.22	125.05	128.46

There are no chirality outliers.

There are no torsion outliers.

There are no ring outliers.

7 monomers are involved in 13 short contacts:

Mol	Chain	Res	Type	Clashes	Symm-Clashes
2	A	501	HEM	3	0
3	A	503	1PE	2	0
2	B	501	HEM	1	0
3	C	501	1PE	3	0
3	C	502	1PE	1	0
2	C	503	HEM	1	0
2	D	501	HEM	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	386/409 (94%)	0.18	11 (2%) 53 54	31, 39, 58, 82	0
1	B	386/409 (94%)	0.15	17 (4%) 35 33	32, 42, 64, 90	0
1	C	386/409 (94%)	0.20	16 (4%) 38 36	40, 45, 62, 89	0
1	D	387/409 (94%)	0.23	13 (3%) 46 45	36, 48, 66, 98	0
All	All	1545/1636 (94%)	0.19	57 (3%) 42 41	31, 44, 64, 98	0

The worst 5 of 57 RSRZ outliers are listed below:

Mol	Chain	Res	Type	RSRZ
1	A	174	ASN	5.7
1	B	174	ASN	5.6
1	B	179	PHE	5.0
1	B	127	SER	4.9
1	D	221	ILE	4.2

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(\AA^2)	Q<0.9
3	1PE	B	502	16/16	0.89	0.26	3.18	44,48,58,59	0
3	1PE	C	502	16/16	0.92	0.23	2.12	41,44,46,47	0
3	1PE	C	501	16/16	0.92	0.26	1.78	41,47,54,57	0
3	1PE	A	503	16/16	0.87	0.23	0.59	57,66,75,77	0
3	1PE	A	502	16/16	0.93	0.16	0.47	36,39,52,53	0
2	HEM	D	501	43/43	0.97	0.20	0.32	42,50,53,54	0
2	HEM	A	501	43/43	0.97	0.21	0.28	38,42,45,46	0
2	HEM	B	501	43/43	0.97	0.19	0.18	41,44,45,49	0
2	HEM	C	503	43/43	0.98	0.17	-0.49	42,48,50,51	0
4	SO4	B	503	5/5	0.97	0.11	-2.89	42,44,48,50	0
4	SO4	A	505	5/5	0.98	0.11	-3.82	52,57,58,60	0
4	SO4	A	504	5/5	0.89	0.13	-	67,67,72,102	0

6.5 Other polymers [i](#)

There are no such residues in this entry.