wwPDB X-ray Structure Validation Summary Report (i)

Feb 1, 2016 – 03:54 PM GMT

PDB ID	:	4DU2
Title	:	cytochrome P450 BM3h-B7 MRI sensor bound to dopamine
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	:	1.90 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
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:

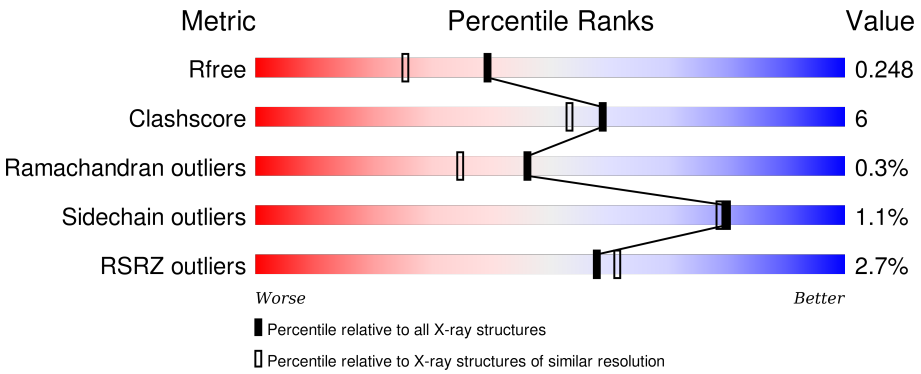
MolProbity	:	4.02b-467
Mogul	:	1.7 (RC4), CSD as536be (2015)
Xtriage (Phenix)	:	1.9-1692
EDS	:	rb-20026688
Percentile statistics	:	20151230.v01 (using entries in the PDB archive December 30th 2015)
Refmac	:	5.8.0135
CCP4	:	6.5.0
Ideal geometry (proteins)	:	Engh & Huber (2001)
Ideal geometry (DNA, RNA)	:	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 1.90 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}	91344	4755 (1.90-1.90)
Clashscore	102246	5398 (1.90-1.90)
Ramachandran outliers	100387	5338 (1.90-1.90)
Sidechain outliers	100360	5339 (1.90-1.90)
RSRZ outliers	91569	4766 (1.90-1.90)

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 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	470	3% 83% 10% • 6%
1	B	470	3% 80% 14% 6%

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
3	LDP	A	501	-	-	-	X

2 Entry composition (i)

There are 4 unique types of molecules in this entry. The entry contains 7584 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 B7.

Mol	Chain	Residues	Atoms					ZeroOcc	AltConf	Trace
			Total	C	N	O	S			
1	B	444	3526	2253	599	656	18	0	2	0
1	A	443	3514	2246	598	653	17	0	0	0

There are 28 discrepancies between the modelled and reference sequences:

Chain	Residue	Modelled	Actual	Comment	Reference
B	75	PRO	LEU	ENGINNERED MUTATION	UNP P14779
B	81	LEU	PHE	ENGINNERED MUTATION	UNP P14779
B	189	ARG	GLN	ENGINNERED MUTATION	UNP P14779
B	263	ALA	ILE	ENGINNERED MUTATION	UNP P14779
B	268	ALA	THR	ENGINNERED MUTATION	UNP P14779
B	286	GLU	VAL	ENGINNERED MUTATION	UNP P14779
B	305	HIS	TYR	ENGINNERED MUTATION	UNP P14779
B	366	VAL	ILE	ENGINNERED MUTATION	UNP P14779
B	464	HIS	-	EXPRESSION TAG	UNP P14779
B	465	HIS	-	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
A	75	PRO	LEU	ENGINNERED MUTATION	UNP P14779
A	81	LEU	PHE	ENGINNERED MUTATION	UNP P14779
A	189	ARG	GLN	ENGINNERED MUTATION	UNP P14779
A	263	ALA	ILE	ENGINNERED MUTATION	UNP P14779
A	268	ALA	THR	ENGINNERED MUTATION	UNP P14779
A	286	GLU	VAL	ENGINNERED MUTATION	UNP P14779
A	305	HIS	TYR	ENGINNERED MUTATION	UNP P14779
A	366	VAL	ILE	ENGINNERED MUTATION	UNP P14779
A	464	HIS	-	EXPRESSION TAG	UNP P14779
A	465	HIS	-	EXPRESSION TAG	UNP P14779
A	466	HIS	-	EXPRESSION TAG	UNP P14779

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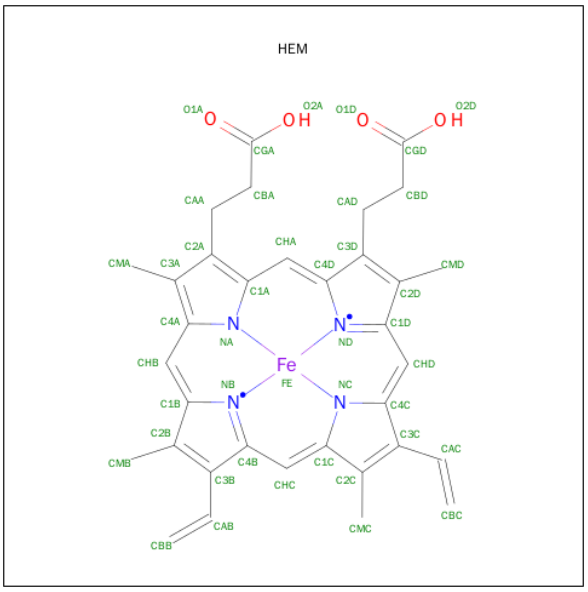
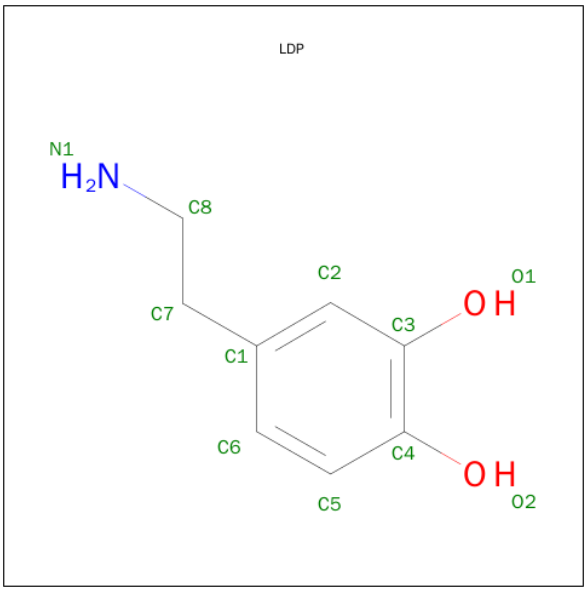
Chain	Residue	Modelled	Actual	Comment	Reference
A	467	HIS	-	EXPRESSION TAG	UNP P14779
A	468	HIS	-	EXPRESSION TAG	UNP P14779
A	469	HIS	-	EXPRESSION TAG	UNP P14779

- 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	B	1	43	34	1	4	4	0	0
			Total	C	Fe	N	O		
2	A	1	43	34	1	4	4	0	0

- Molecule 3 is L-DOPAMINE (three-letter code: LDP) (formula: $C_8H_{11}NO_2$).



Mol	Chain	Residues	Atoms				ZeroOcc	AltConf
			Total	C	N	O		
3	B	1	11	8	1	2	0	0
			Total	C	N	O		
3	A	1	11	8	1	2	0	0

- Molecule 4 is water.

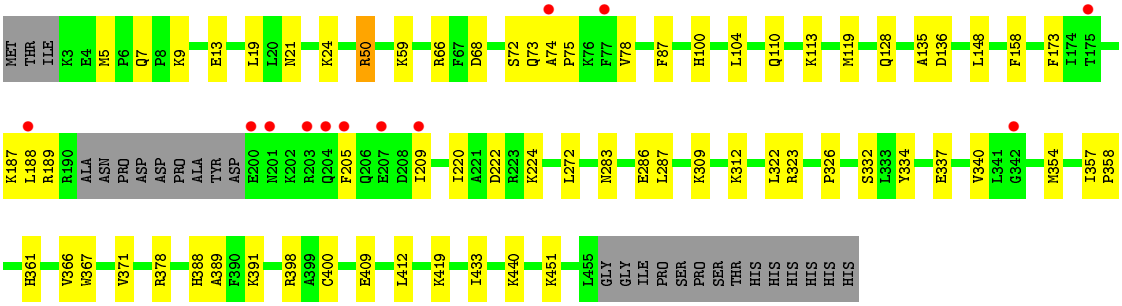
Mol	Chain	Residues	Atoms		ZeroOcc	AltConf
			Total	O		
4	B	221	221	221	0	0
			Total	O		
4	A	215	215	215	0	0

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.

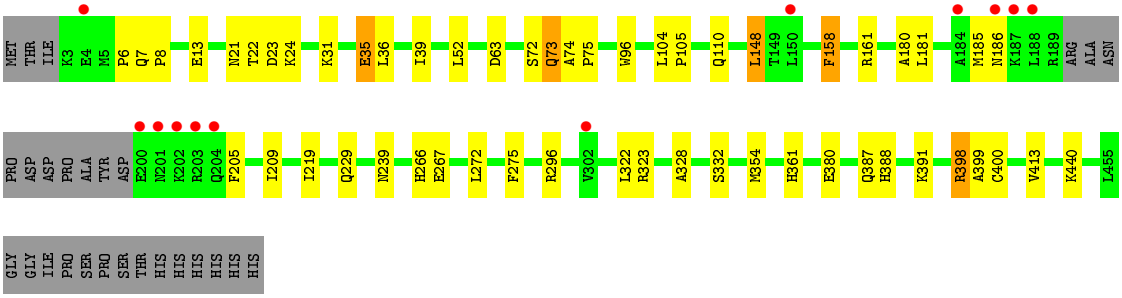
- Molecule 1: cytochrome P450 BM3 variant B7

Chain B:



- Molecule 1: cytochrome P450 BM3 variant B7

Chain A:



4 Data and refinement statistics (i)

Property	Value	Source
Space group	P 1 21 1	Depositor
Cell constants a, b, c, α, β, γ	58.74Å 147.24Å 63.22Å 90.00° 98.12° 90.00°	Depositor
Resolution (Å)	38.99 – 1.90 38.99 – 1.90	Depositor EDS
% Data completeness (in resolution range)	94.0 (38.99-1.90) 94.0 (38.99-1.90)	Depositor EDS
R_{merge}	(Not available)	Depositor
R_{sym}	0.05	Depositor
$< I/\sigma(I) >$ [1]	1.57 (at 1.89Å)	Xtriage
Refinement program	REFMAC 5.5.0109	Depositor
R, R_{free}	0.198 , 0.250 0.198 , 0.248	Depositor DCC
R_{free} test set	4304 reflections (5.79%)	DCC
Wilson B-factor (Å^2)	30.2	Xtriage
Anisotropy	0.019	Xtriage
Bulk solvent k_{sol}(e/Å^3), B_{sol}(Å^2)	0.36 , 46.9	EDS
Estimated twinning fraction	No twinning to report.	Xtriage
L-test for twinning[2]	$< \|L\| > = 0.46$, $< L^2 > = 0.29$	Xtriage
Outliers	0 of 78406 reflections	Xtriage
F_o,F_c correlation	0.95	EDS
Total number of atoms	7584	wwPDB-VP
Average B, all atoms (Å^2)	31.0	wwPDB-VP

Xtriage's analysis on translational NCS is as follows: *The largest off-origin peak in the Patterson function is 9.95% 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, 0.375 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, LDP

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	1.06	4/3595 (0.1%)	0.92	4/4867 (0.1%)
1	B	1.03	1/3612 (0.0%)	0.93	3/4889 (0.1%)
All	All	1.04	5/7207 (0.1%)	0.93	7/9756 (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

All (5) bond length outliers are listed below:

Mol	Chain	Res	Type	Atoms	Z	Observed(Å)	Ideal(Å)
1	A	399	ALA	CA-CB	6.46	1.66	1.52
1	B	87	PHE	CE2-CZ	6.08	1.49	1.37
1	A	35	GLU	CG-CD	5.50	1.60	1.51
1	A	13	GLU	CB-CG	5.35	1.62	1.52
1	A	275	PHE	CD2-CE2	5.09	1.49	1.39

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

Mol	Chain	Res	Type	Atoms	Z	Observed(^{o})	Ideal(^{o})
1	A	161	ARG	NE-CZ-NH2	-9.60	115.50	120.30
1	A	161	ARG	NE-CZ-NH1	8.00	124.30	120.30
1	A	398	ARG	NE-CZ-NH1	-5.95	117.32	120.30
1	A	63	ASP	CB-CG-OD1	5.94	123.65	118.30
1	B	323	ARG	NE-CZ-NH2	-5.12	117.74	120.30

There are no chirality outliers.

All (1) planarity outliers are listed below:

Mol	Chain	Res	Type	Group
1	A	328	ALA	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	3514	0	3427	31	1
1	B	3526	0	3441	47	0
2	A	43	0	30	3	0
2	B	43	0	30	4	0
3	A	11	0	9	0	0
3	B	11	0	9	0	0
4	A	215	0	0	3	0
4	B	221	0	0	5	1
All	All	7584	0	6946	82	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 6.

The worst 5 of 82 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:119:MET:HE1	1:B:409:GLU:HA	1.13	1.08
1:B:119:MET:HE1	1:B:409:GLU:CA	2.00	0.90
1:A:22:THR:HG22	1:A:24:LYS:H	1.33	0.90
1:B:366:VAL:HG11	1:B:389:ALA:HB1	1.59	0.84
1:B:119:MET:CE	1:B:409:GLU:HA	2.05	0.83

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:A:380:GLU:OE2	4:B:777:HOH:O[2_455]	2.14	0.06

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	439/470 (93%)	419 (95%)	18 (4%)	2 (0%)	34	21
1	B	442/470 (94%)	424 (96%)	17 (4%)	1 (0%)	52	42
All	All	881/940 (94%)	843 (96%)	35 (4%)	3 (0%)	46	35

All (3) Ramachandran outliers are listed below:

Mol	Chain	Res	Type
1	B	188	LEU
1	A	186	ASN
1	A	73	GLN

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	370/410 (90%)	367 (99%)	3 (1%)	86	86
1	B	371/410 (90%)	366 (99%)	5 (1%)	76	73
All	All	741/820 (90%)	733 (99%)	8 (1%)	80	79

5 of 8 residues with a non-rotameric sidechain are listed below:

Mol	Chain	Res	Type
1	B	148	LEU
1	A	158	PHE
1	A	110	GLN

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Mol	Chain	Res	Type
1	B	59	LYS
1	B	158	PHE

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

Mol	Chain	Res	Type
1	B	110	GLN
1	B	169	GLN
1	A	110	GLN
1	A	169	GLN
1	A	229	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)

4 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	30,50,50	2.34	8 (26%)	24,82,82	2.61	15 (62%)

Mol	Type	Chain	Res	Link	Bond lengths			Bond angles		
					Counts	RMSZ	$\#\|Z\| > 2$	Counts	RMSZ	$\#\|Z\| > 2$
3	LDP	A	501	2	10,11,11	1.72	1 (10%)	13,14,14	1.35	2 (15%)
2	HEM	B	500	1,3	30,50,50	2.00	5 (16%)	24,82,82	2.64	11 (45%)
3	LDP	B	501	2	10,11,11	1.60	2 (20%)	13,14,14	1.92	6 (46%)

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	-	0/10/54/54	0/0/8/8
3	LDP	A	501	2	-	0/3/3/3	0/1/1/1
2	HEM	B	500	1,3	-	0/10/54/54	0/0/8/8
3	LDP	B	501	2	-	0/3/3/3	0/1/1/1

The worst 5 of 16 bond length outliers are listed below:

Mol	Chain	Res	Type	Atoms	Z	Observed(Å)	Ideal(Å)
2	A	500	HEM	C3B-C4B	-7.88	1.44	1.51
2	B	500	HEM	C3B-C4B	-5.83	1.46	1.51
2	B	500	HEM	C3D-C4D	-4.51	1.45	1.51
2	B	500	HEM	C2C-C1C	-4.48	1.44	1.52
2	A	500	HEM	C2C-C1C	-4.37	1.44	1.52

The worst 5 of 34 bond angle outliers are listed below:

Mol	Chain	Res	Type	Atoms	Z	Observed(^{o})	Ideal(^{o})
2	A	500	HEM	CMA-C3A-C4A	-4.94	120.19	128.36
2	B	500	HEM	C3C-CAC-CBC	-4.22	117.99	124.46
3	B	501	LDP	C5-C6-C1	-3.18	116.68	121.04
2	B	500	HEM	CBD-CAD-C3D	-2.90	105.13	113.55
2	A	500	HEM	CBD-CAD-C3D	-2.75	105.55	113.55

There are no chirality outliers.

There are no torsion outliers.

There are no ring outliers.

2 monomers are involved in 7 short contacts:

Mol	Chain	Res	Type	Clashes	Symm-Clashes
2	A	500	HEM	3	0

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Mol	Chain	Res	Type	Clashes	Symm-Clashes
2	B	500	HEM	4	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	443/470 (94%)	0.08	12 (2%)	58	61	18, 29, 49, 76	0
1	B	444/470 (94%)	0.07	12 (2%)	58	61	17, 29, 51, 79	0
All	All	887/940 (94%)	0.07	24 (2%)	58	61	17, 29, 49, 79	0

The worst 5 of 24 RSRZ outliers are listed below:

Mol	Chain	Res	Type	RSRZ
1	A	188	LEU	5.2
1	A	200	GLU	4.8
1	B	205	PHE	4.5
1	B	200	GLU	4.1
1	A	203	ARG	4.0

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 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
3	LDP	A	501	11/11	0.91	0.15	2.03	22,24,25,26	0
2	HEM	A	500	43/43	0.98	0.12	0.57	13,18,22,25	0
2	HEM	B	500	43/43	0.98	0.12	0.23	13,18,22,32	0
3	LDP	B	501	11/11	0.94	0.14	0.22	19,23,26,29	0

6.5 Other polymers (i)

There are no such residues in this entry.