wwPDB X-ray Structure Validation Summary Report (i)

Aug 17, 2022 – 10:44 PM EDT

PDB ID	:	3WFB
Title	:	Reduced cytochrome c-dependent nitric oxide reductase (cNOR) from Pseudomonas aeruginosa in complex with antibody fragment
Authors	:	Sato, N.; Ishii, S.; Hino, T.; Sugimoto, H.; Fukumori, Y.; Shiro, Y.; Tosha, T.
Deposited on	:	2013-07-18
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
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:

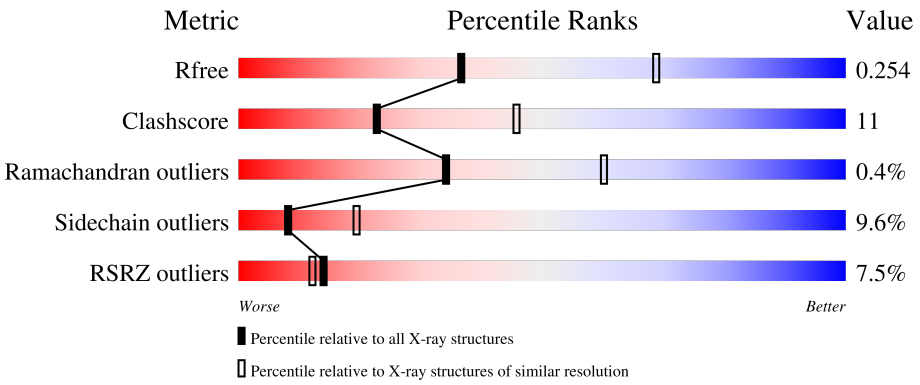
MolProbity	:	4.02b-467
Mogul	:	1.8.5 (274361), CSD as541be (2020)
Xtriage (Phenix)	:	1.13
EDS	:	2.29
buster-report	:	1.1.7 (2018)
Percentile statistics	:	20191225.v01 (using entries in the PDB archive December 25th 2019)
Refmac	:	5.8.0158
CCP4	:	7.0.044 (Gargrove)
Ideal geometry (proteins)	:	Engh & Huber (2001)
Ideal geometry (DNA, RNA)	:	Parkinson et al. (1996)
Validation Pipeline (wwPDB-VP)	:	2.29

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 2.70 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}	130704	2808 (2.70-2.70)
Clashscore	141614	3122 (2.70-2.70)
Ramachandran outliers	138981	3069 (2.70-2.70)
Sidechain outliers	138945	3069 (2.70-2.70)
RSRZ outliers	127900	2737 (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 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	L	213	78% 17% 5%
2	H	225	3% 78% 17% •
3	B	465	12% 69% 24% • •
4	C	146	8% 67% 27% • •

2 Entry composition (i)

There are 10 unique types of molecules in this entry. The entry contains 8326 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 antibody fab fragment light chain.

Mol	Chain	Residues	Atoms					ZeroOcc	AltConf	Trace
			Total	C	N	O	S			
1	L	213	1669	1047	277	338	7	0	0	0

- Molecule 2 is a protein called antibody fab fragment heavy chain.

Mol	Chain	Residues	Atoms					ZeroOcc	AltConf	Trace
			Total	C	N	O	S			
2	H	225	1692	1065	280	338	9	0	0	0

- Molecule 3 is a protein called Nitric oxide reductase subunit B.

Mol	Chain	Residues	Atoms					ZeroOcc	AltConf	Trace
			Total	C	N	O	S			
3	B	449	3576	2416	563	572	25	0	0	0

There is a discrepancy between the modelled and reference sequences:

Chain	Residue	Modelled	Actual	Comment	Reference
B	?	-	ARG	deletion	UNP Q59647

- Molecule 4 is a protein called Nitric oxide reductase subunit C.

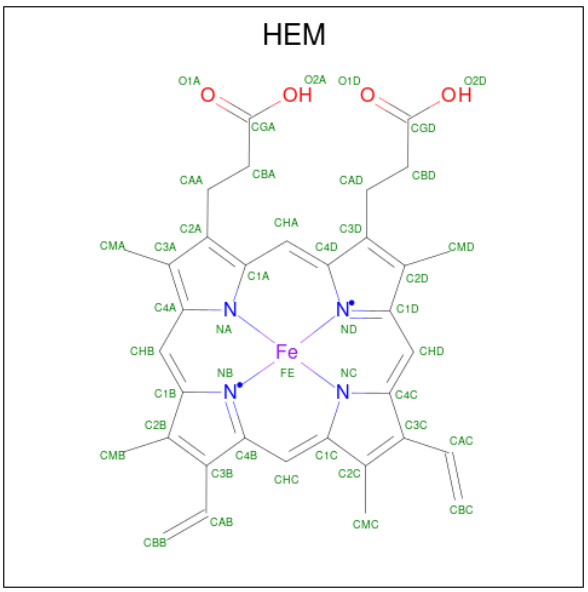
Mol	Chain	Residues	Atoms					ZeroOcc	AltConf	Trace
			Total	C	N	O	S			
4	C	142	1123	720	195	202	6	0	0	0

There is a discrepancy between the modelled and reference sequences:

Chain	Residue	Modelled	Actual	Comment	Reference
C	100	LYS	ASN	conflict	UNP Q59646

- Molecule 5 is PROTOPORPHYRIN IX CONTAINING FE (three-letter code: HEM) (for-

mula: $C_{34}H_{32}FeN_4O_4$).



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

- Molecule 6 is FE (III) ION (three-letter code: FE) (formula: Fe).

Mol	Chain	Residues	Atoms		ZeroOcc	AltConf
			Total	Fe		
6	B	1	1	1	0	0

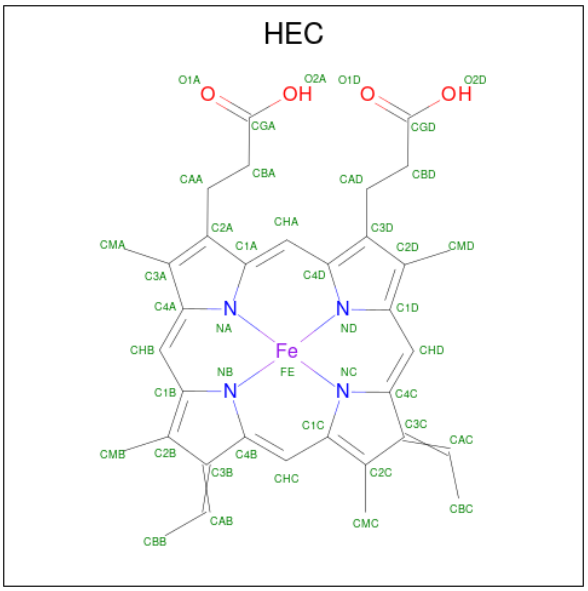
- Molecule 7 is CHLORIDE ION (three-letter code: CL) (formula: Cl).

Mol	Chain	Residues	Atoms		ZeroOcc	AltConf
			Total	Cl		
7	B	1	1	1	0	0

- Molecule 8 is CALCIUM ION (three-letter code: CA) (formula: Ca).

Mol	Chain	Residues	Atoms		ZeroOcc	AltConf
			Total	Ca		
8	B	1	1	1	0	0

- Molecule 9 is HEME C (three-letter code: HEC) (formula: $C_{34}H_{34}FeN_4O_4$).



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

- Molecule 10 is water.

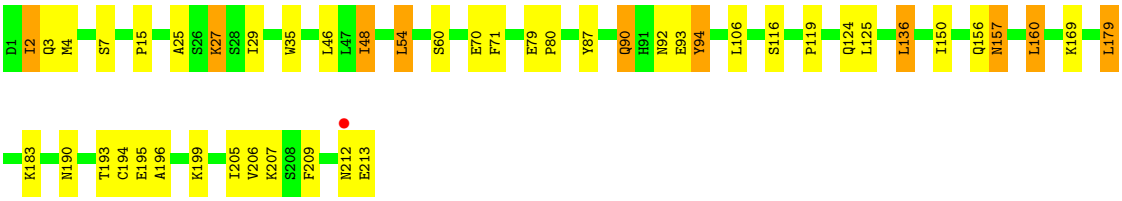
Mol	Chain	Residues	Atoms		ZeroOcc	AltConf
			Total	O		
10	L	39	39	39	0	0
			Total	O		
10	H	42	42	42	0	0
			Total	O		
10	B	24	24	24	0	0
			Total	O		
10	C	29	29	29	0	0

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.

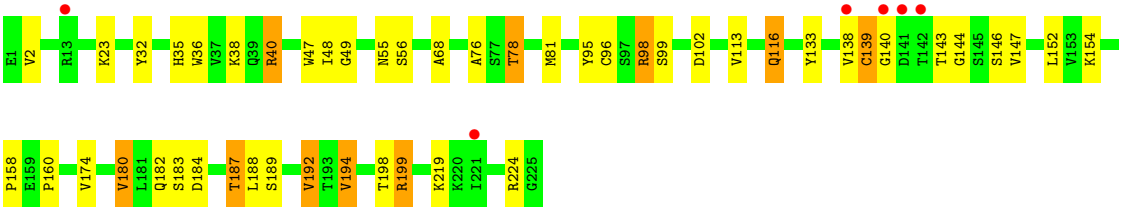
• Molecule 1: antibody fab fragment light chain

Chain L:



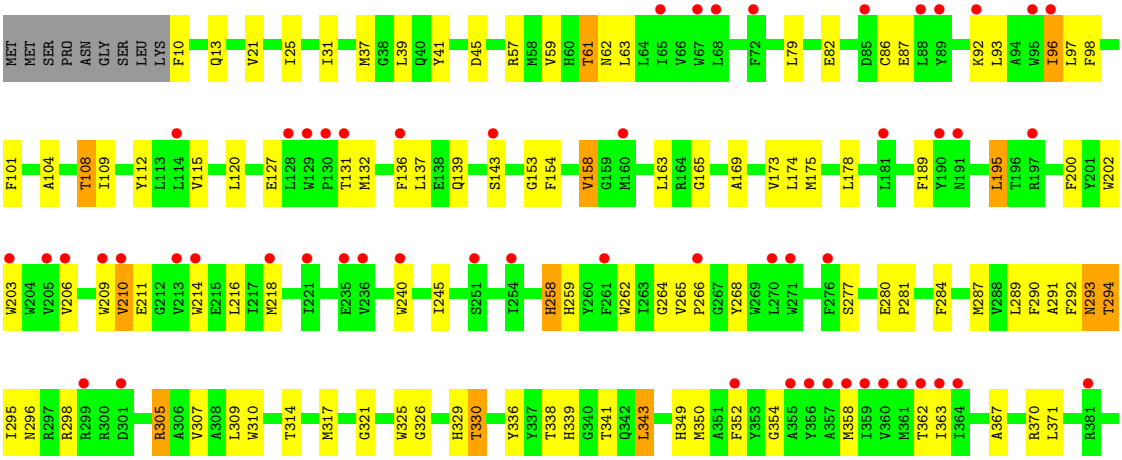
• Molecule 2: antibody fab fragment heavy chain

Chain H:



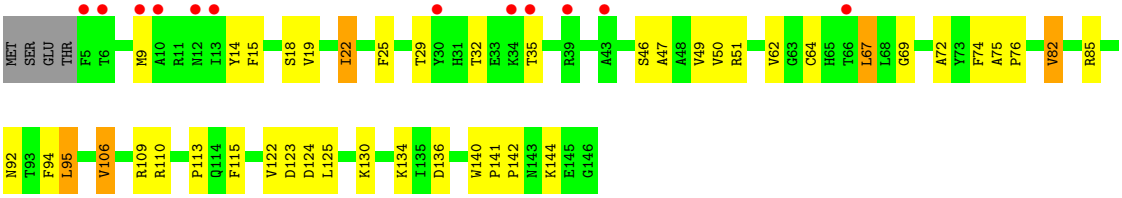
• Molecule 3: Nitric oxide reductase subunit B

Chain B:



• Molecule 4: Nitric oxide reductase subunit C

Chain C:



4 Data and refinement statistics (i)

Property	Value	Source
Space group	P 21 21 21	Depositor
Cell constants a, b, c, α, β, γ	90.76Å 110.64Å 193.55Å 90.00° 90.00° 90.00°	Depositor
Resolution (Å)	41.07 – 2.70 41.03 – 2.70	Depositor EDS
% Data completeness (in resolution range)	99.4 (41.07-2.70) 99.4 (41.03-2.70)	Depositor EDS
R_{merge}	0.08	Depositor
R_{sym}	0.08	Depositor
$< I/\sigma(I) >$ [1]	1.92 (at 2.69Å)	Xtriage
Refinement program	REFMAC 5.7.0029	Depositor
R, R_{free}	0.202 , 0.250 0.204 , 0.254	Depositor DCC
R_{free} test set	2744 reflections (5.09%)	wwPDB-VP
Wilson B-factor (Å^2)	63.7	Xtriage
Anisotropy	0.291	Xtriage
Bulk solvent k_{sol}(e/Å^3), B_{sol}(Å^2)	0.29 , 48.9	EDS
L-test for twinning[2]	$< \|L\| > = 0.49$, $< L^2 > = 0.33$	Xtriage
Estimated twinning fraction	No twinning to report.	Xtriage
F_o,F_c correlation	0.94	EDS
Total number of atoms	8326	wwPDB-VP
Average B, all atoms (Å^2)	80.0	wwPDB-VP

Xtriage's analysis on translational NCS is as follows: *The largest off-origin peak in the Patterson function is 3.58% 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: FE, CL, HEM, HEC, CA

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	L	0.87	0/1709	0.95	2/2317 (0.1%)
2	H	0.83	0/1735	0.90	0/2367
3	B	0.72	0/3693	0.78	1/5039 (0.0%)
4	C	0.66	0/1153	0.78	0/1559
All	All	0.77	0/8290	0.84	3/11282 (0.0%)

There are no bond length outliers.

All (3) bond angle outliers are listed below:

Mol	Chain	Res	Type	Atoms	Z	Observed(^{o})	Ideal(^{o})
1	L	4	MET	CB-CG-SD	-5.55	95.74	112.40
3	B	45	ASP	CB-CG-OD1	5.38	123.14	118.30
1	L	48	ILE	CB-CA-C	-5.11	101.38	111.60

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	L	1669	0	1606	35	1
2	H	1692	0	1647	39	0
3	B	3576	0	3619	91	1
4	C	1123	0	1091	26	0

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Mol	Chain	Non-H	H(model)	H(added)	Clashes	Symm-Clashes
5	B	86	0	60	21	0
6	B	1	0	0	0	0
7	B	1	0	0	1	0
8	B	1	0	0	0	0
9	C	43	0	30	3	0
10	B	24	0	0	1	0
10	C	29	0	0	0	0
10	H	42	0	0	1	0
10	L	39	0	0	1	0
All	All	8326	0	8053	186	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 11.

The worst 5 of 186 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:H:199:ARG:HH11	2:H:199:ARG:HG3	1.13	1.11
2:H:199:ARG:HH11	2:H:199:ARG:CG	1.84	0.90
4:C:25:PHE:O	4:C:29:THR:HG23	1.78	0.84
4:C:32:THR:O	4:C:35:THR:HG22	1.79	0.83
2:H:199:ARG:HG3	2:H:199:ARG:NH1	1.81	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:L:157:ASN:ND2	3:B:165:GLY:O[2_554]	2.08	0.12

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	L	211/213 (99%)	202 (96%)	9 (4%)	0	100	100
2	H	223/225 (99%)	208 (93%)	12 (5%)	3 (1%)	12	30
3	B	447/465 (96%)	427 (96%)	19 (4%)	1 (0%)	47	73
4	C	140/146 (96%)	135 (96%)	5 (4%)	0	100	100
All	All	1021/1049 (97%)	972 (95%)	45 (4%)	4 (0%)	34	60

All (4) Ramachandran outliers are listed below:

Mol	Chain	Res	Type
3	B	457	SER
2	H	140	GLY
2	H	144	GLY
2	H	139	CYS

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	L	189/189 (100%)	172 (91%)	17 (9%)	9	22
2	H	192/192 (100%)	176 (92%)	16 (8%)	11	25
3	B	360/371 (97%)	324 (90%)	36 (10%)	7	18
4	C	116/120 (97%)	103 (89%)	13 (11%)	6	13
All	All	857/872 (98%)	775 (90%)	82 (10%)	8	19

5 of 82 residues with a non-rotameric sidechain are listed below:

Mol	Chain	Res	Type
3	B	363	ILE
4	C	19	VAL
3	B	392	LEU
3	B	433	LEU
4	C	67	LEU

Sometimes sidechains can be flipped to improve hydrogen bonding and reduce clashes. All (3) such

sidechains are listed below:

Mol	Chain	Res	Type
1	L	212	ASN
3	B	62	ASN
3	B	139	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)

Of 6 ligands modelled in this entry, 3 are monoatomic - leaving 3 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	$\#\|Z\| > 2$
5	HEM	B	802	3,8	41,50,50	1.99	11 (26%)	45,82,82	2.19	9 (20%)
9	HEC	C	201	4	32,50,50	2.15	5 (15%)	24,82,82	2.27	9 (37%)
5	HEM	B	801	3,8	41,50,50	2.03	9 (21%)	45,82,82	1.75	6 (13%)

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
5	HEM	B	802	3,8	-	4/12/54/54	-
9	HEC	C	201	4	-	0/10/54/54	-
5	HEM	B	801	3,8	-	7/12/54/54	-

The worst 5 of 25 bond length outliers are listed below:

Mol	Chain	Res	Type	Atoms	Z	Observed(Å)	Ideal(Å)
5	B	802	HEM	C3D-C2D	7.69	1.53	1.36
5	B	801	HEM	C3D-C2D	6.51	1.50	1.36
9	C	201	HEC	C3C-C2C	-6.05	1.34	1.40
9	C	201	HEC	C2B-C3B	-5.75	1.34	1.40
9	C	201	HEC	C3D-C2D	5.56	1.54	1.37

The worst 5 of 24 bond angle outliers are listed below:

Mol	Chain	Res	Type	Atoms	Z	Observed(^{o})	Ideal(^{o})
5	B	802	HEM	CBA-CAA-C2A	-7.84	99.24	112.62
5	B	802	HEM	C4D-ND-C1D	6.42	111.71	105.07
5	B	801	HEM	C4C-CHD-C1D	4.85	128.95	122.56
9	C	201	HEC	CBD-CAD-C3D	-4.60	104.78	112.62
5	B	801	HEM	CMD-C2D-C1D	4.48	131.85	125.04

There are no chirality outliers.

5 of 11 torsion outliers are listed below:

Mol	Chain	Res	Type	Atoms
5	B	801	HEM	C3D-CAD-CBD-CGD
5	B	801	HEM	C4D-C3D-CAD-CBD
5	B	801	HEM	C2D-C3D-CAD-CBD
5	B	801	HEM	CAD-CBD-CGD-O1D
5	B	802	HEM	CAA-CBA-CGA-O2A

There are no ring outliers.

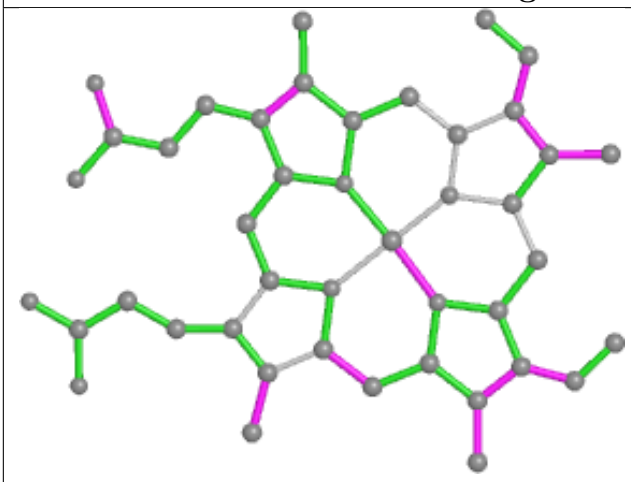
3 monomers are involved in 24 short contacts:

Mol	Chain	Res	Type	Clashes	Symm-Clashes
5	B	802	HEM	5	0
9	C	201	HEC	3	0
5	B	801	HEM	16	0

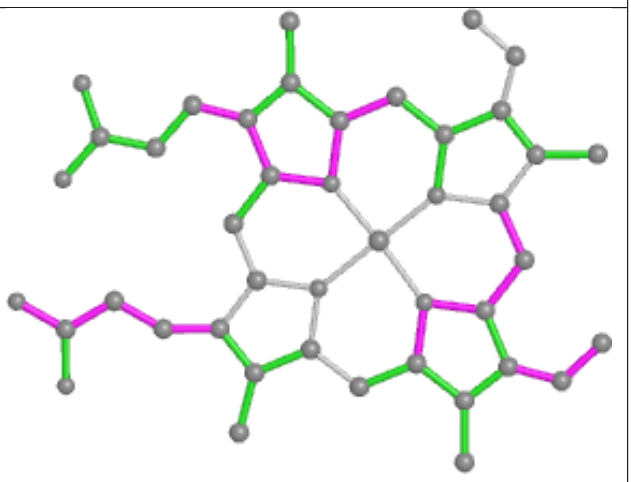
The following is a two-dimensional graphical depiction of Mogul quality analysis of bond lengths, bond angles, torsion angles, and ring geometry for all instances of the Ligand of Interest. In

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.

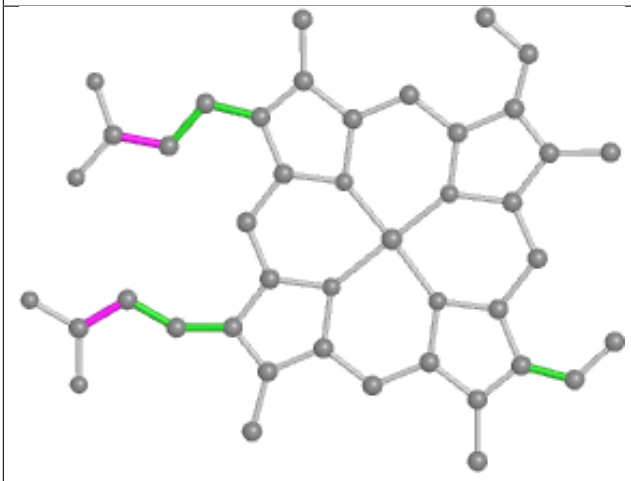
Ligand HEM B 802



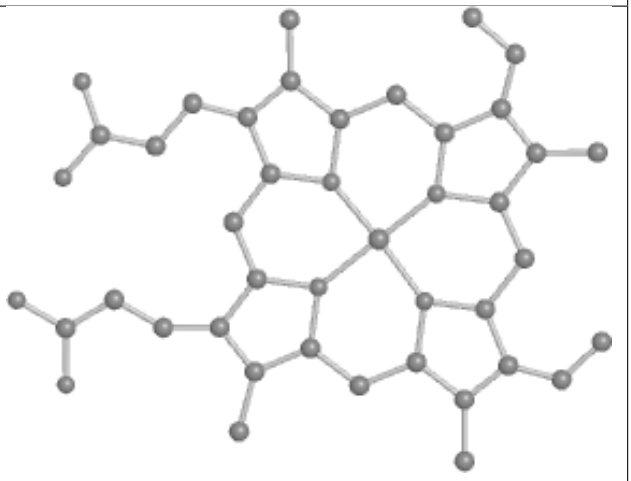
Bond lengths



Bond angles

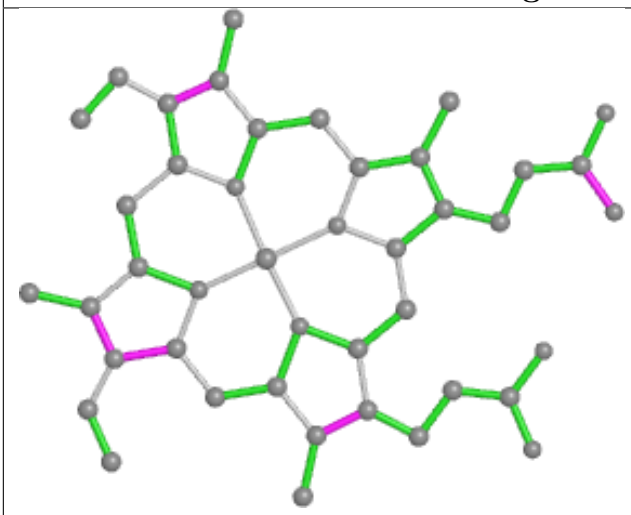


Torsions

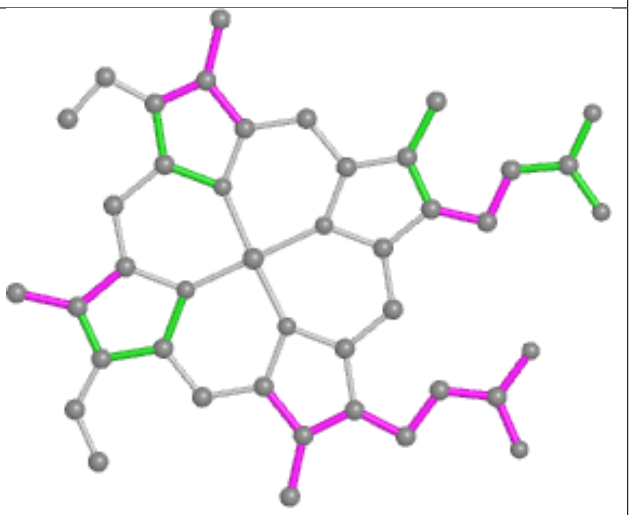


Rings

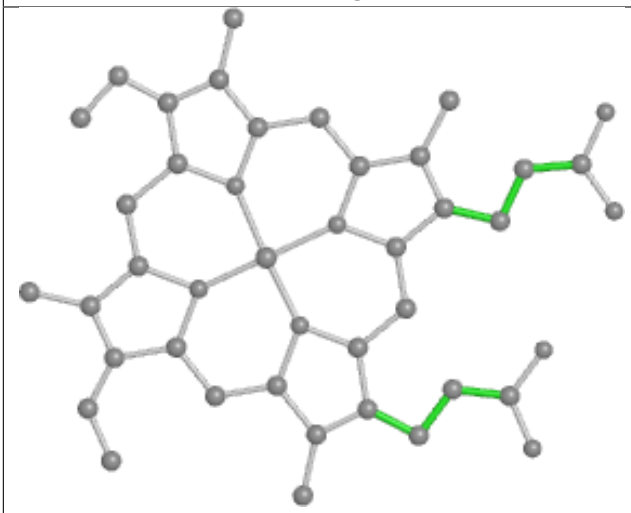
Ligand HEC C 201



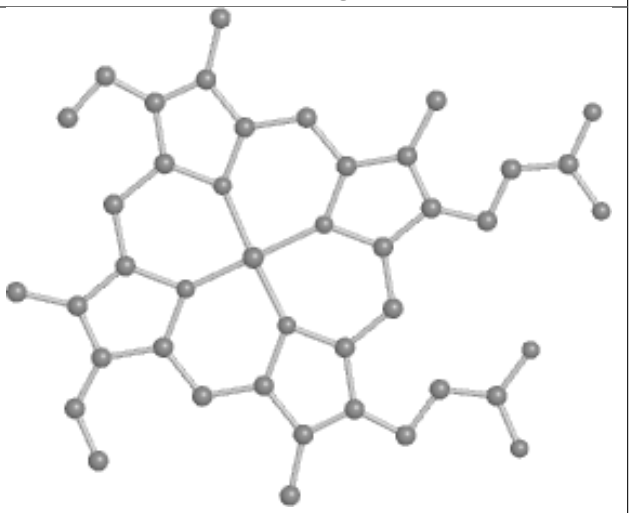
Bond lengths



Bond angles

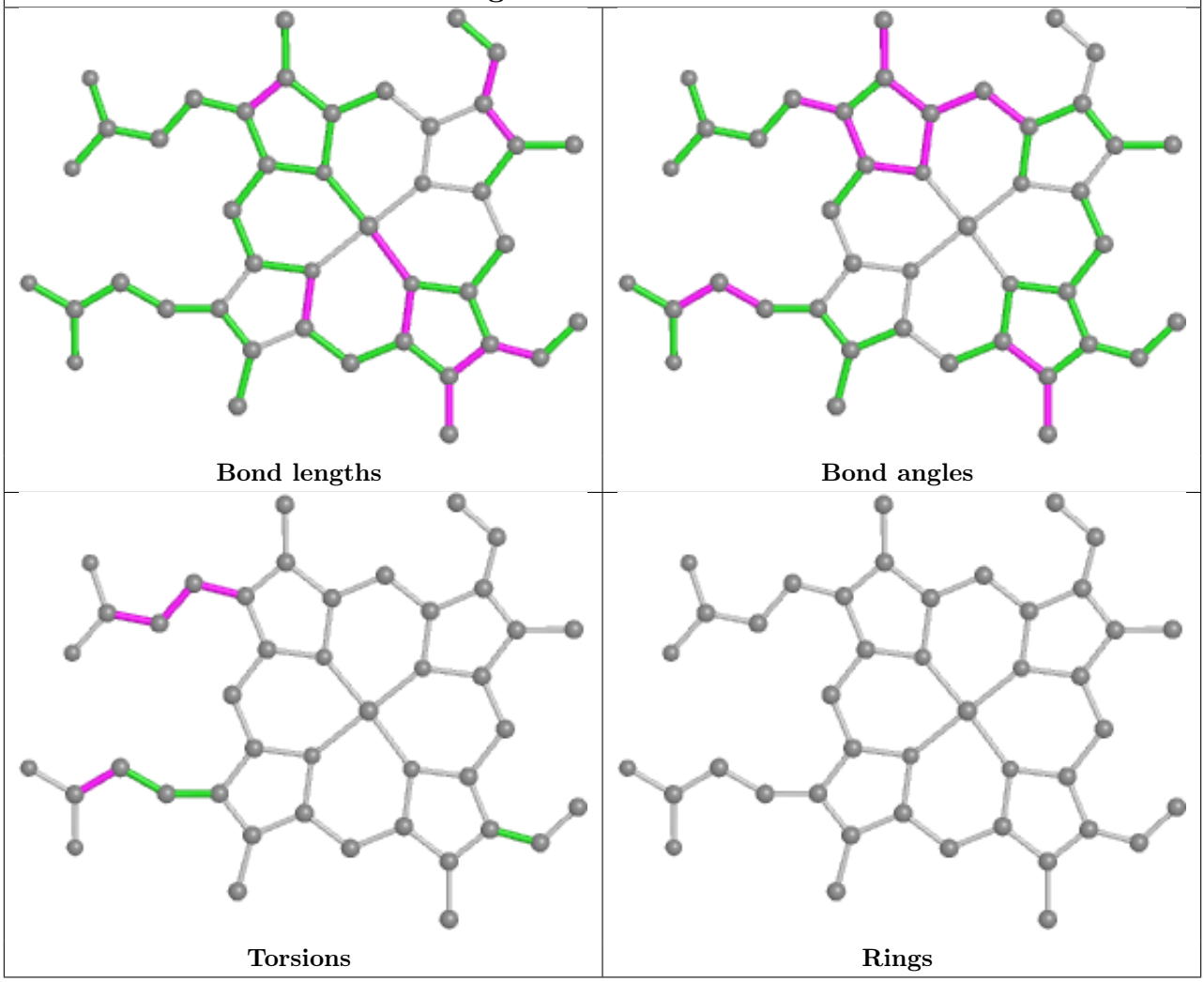


Torsions



Rings

Ligand HEM B 801



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	L	213/213 (100%)	-0.32	1 (0%) 91 92	47, 62, 94, 150	0
2	H	225/225 (100%)	-0.22	6 (2%) 54 55	46, 62, 102, 201	0
3	B	449/465 (96%)	0.48	58 (12%) 3 2	54, 86, 127, 165	0
4	C	142/146 (97%)	0.25	12 (8%) 10 9	51, 85, 133, 156	0
All	All	1029/1049 (98%)	0.13	77 (7%) 14 12	46, 76, 126, 201	0

The worst 5 of 77 RSRZ outliers are listed below:

Mol	Chain	Res	Type	RSRZ
3	B	129	TRP	7.8
3	B	381	ARG	6.7
2	H	142	THR	6.7
4	C	9	MET	5.6
4	C	5	PHE	5.5

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)

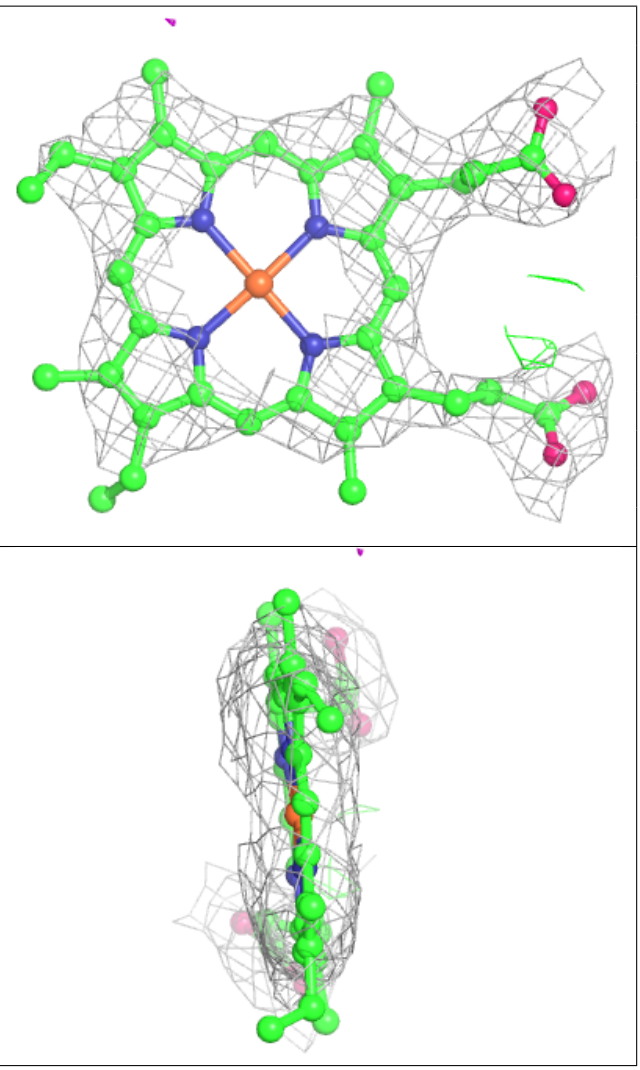
In the following table, the Atoms column lists the number of modelled atoms in the group and the number defined in the chemical component dictionary. The B-factors column lists the minimum, median, 95th percentile and maximum values of B factors of atoms in the group. The column labelled 'Q< 0.9' lists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

Mol	Type	Chain	Res	Atoms	RSCC	RSR	B-factors(Å^2)	Q<0.9
5	HEM	B	802	43/43	0.96	0.24	70,77,86,90	0
7	CL	B	804	1/1	0.96	0.29	68,68,68,68	0
5	HEM	B	801	43/43	0.97	0.25	58,67,80,84	0
8	CA	B	805	1/1	0.98	0.22	73,73,73,73	0
9	HEC	C	201	43/43	0.98	0.21	54,61,66,68	0
6	FE	B	803	1/1	0.99	0.16	74,74,74,74	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.

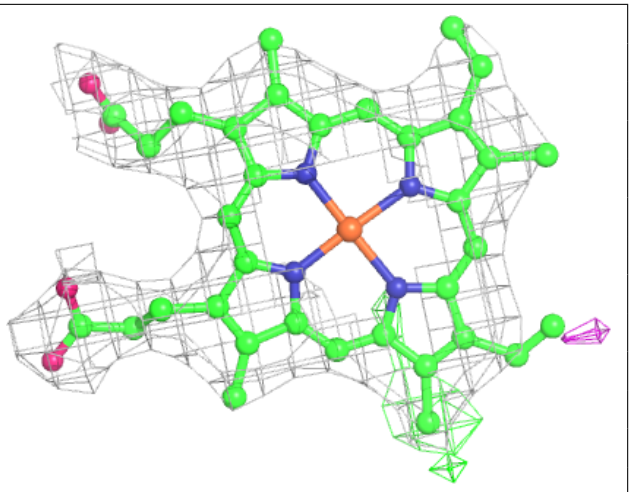
Electron density around HEM B 802:

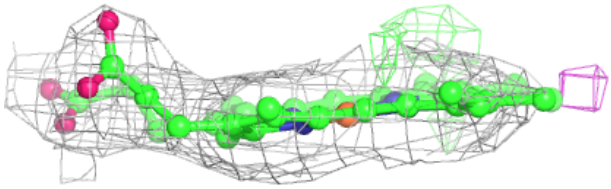
2mF$_o$-DF$_c$ (at 0.7 rmsd) in gray
mF$_o$-DF$_c$ (at 3 rmsd) in purple (negative) and green (positive)

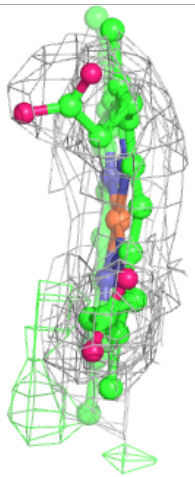


Electron density around HEM B 801:

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

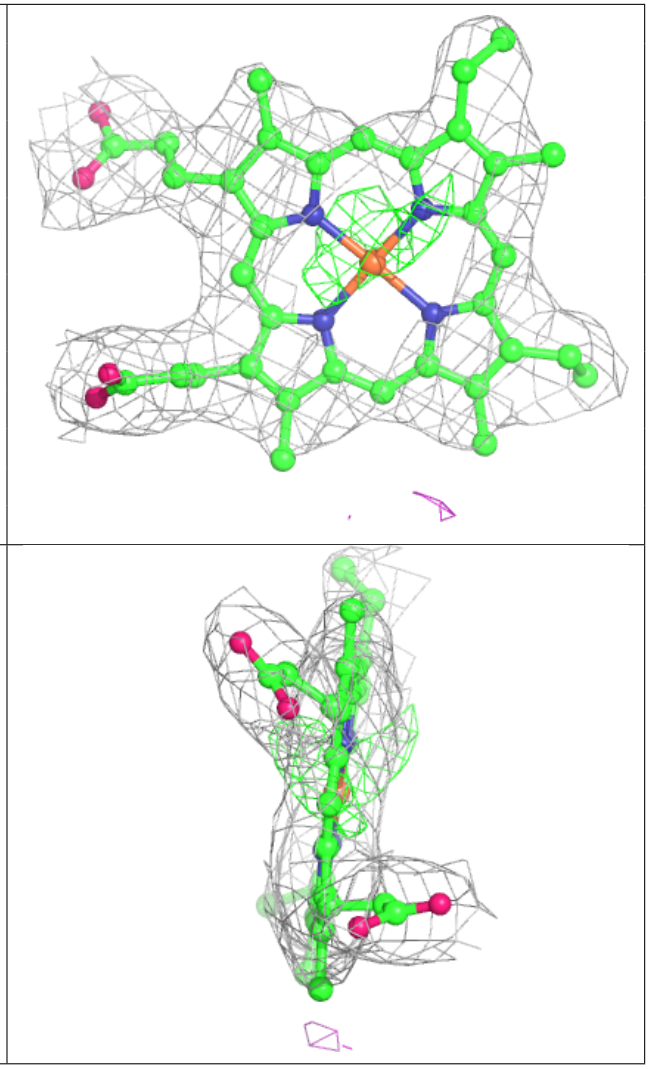


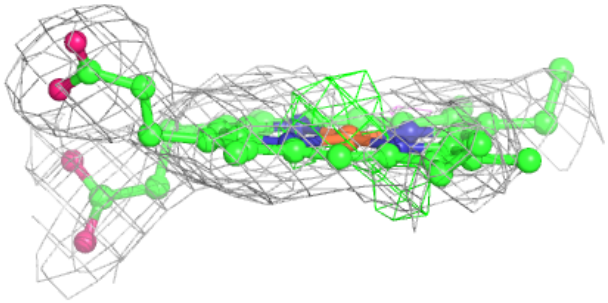




Electron density around HEC C 201:

$2mF_o$-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.