



Full wwPDB X-ray Structure Validation Report ⓘ

May 27, 2020 – 12:21 am BST

PDB ID : 2LHB
Title : REFINEMENT OF A MOLECULAR MODEL FOR LAMPREY
HEMOGLOBIN FROM PETROMYZON MARINUS
Authors : Honzatko, R.B.; Hendrickson, W.A.; Love, W.E.
Deposited on : 1985-08-16
Resolution : 2.00 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 ⓘ symbol.

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

MolProbity : 4.02b-467
Mogul : 1.8.5 (274361), CSD as541be (2020)
Xtriage (Phenix) : **NOT EXECUTED**
EDS : **NOT EXECUTED**
buster-report : 1.1.7 (2018)
Percentile statistics : 20191225.v01 (using entries in the PDB archive December 25th 2019)
Ideal geometry (proteins) : Engh & Huber (2001)
Ideal geometry (DNA, RNA) : Parkinson et al. (1996)
Validation Pipeline (wwPDB-VP) : 2.11

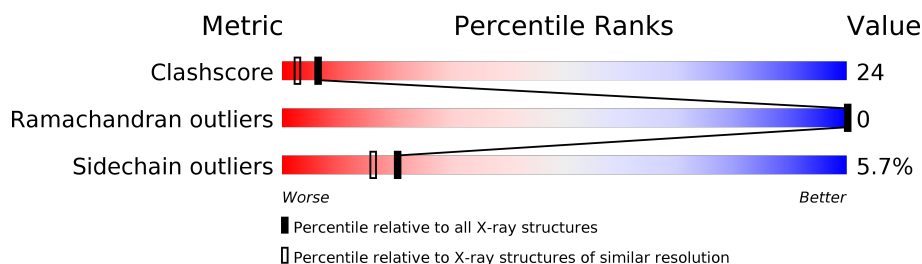
1 Overall quality at a glance

The following experimental techniques were used to determine the structure:

X-RAY DIFFRACTION

The reported resolution of this entry is 2.00 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))
Clashscore	141614	9178 (2.00-2.00)
Ramachandran outliers	138981	9054 (2.00-2.00)
Sidechain outliers	138945	9053 (2.00-2.00)

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 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 $\leq 5\%$.

Note EDS was not executed.

Mol	Chain	Length	Quality of chain
1	A	150	

2 Entry composition

There are 4 unique types of molecules in this entry. The entry contains 2620 atoms, of which 1155 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.

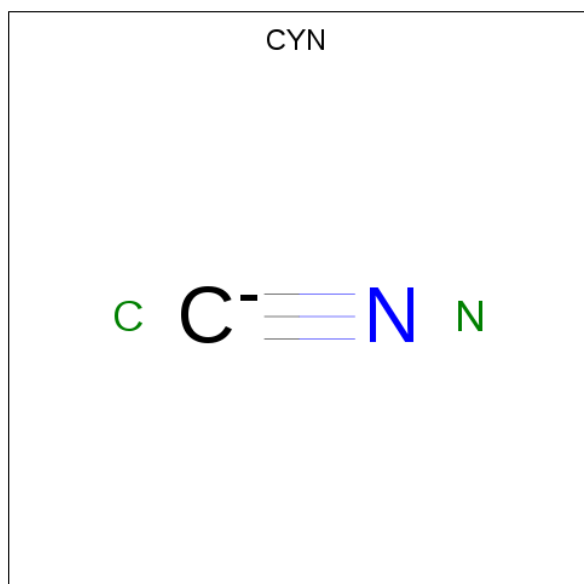
- Molecule 1 is a protein called HEMOGLOBIN V (CYANO MET).

Mol	Chain	Residues	Atoms						ZeroOcc	AltConf	Trace
			Total	C	H	N	O	S			
1	A	149	2360	774	1155	196	228	7	0	13	0

There are 4 discrepancies between the modelled and reference sequences:

Chain	Residue	Modelled	Actual	Comment	Reference
A	63	GLU	GLN	CONFLICT	UNP P02208
A	82	ASP	ASN	CONFLICT	UNP P02208
A	100	ASN	ASP	CONFLICT	UNP P02208
A	114	GLU	GLN	CONFLICT	UNP P02208

- Molecule 2 is CYANIDE ION (three-letter code: CYN) (formula: CN).



Mol	Chain	Residues	Atoms			ZeroOcc	AltConf
			Total	C	N		
2	A	1	2	1	1	0	0

- Molecule 3 is PROTOPORPHYRIN IX CONTAINING FE (three-letter code: HEM) (formula: $C_{34}H_{32}FeN_4O_4$).



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

- Molecule 4 is water.

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

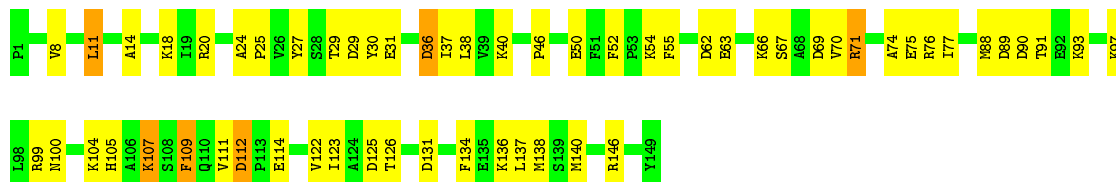
3 Residue-property plots [i](#)

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

Note EDS was not executed.

• Molecule 1: HEMOGLOBIN V (CYANO MET)

Chain A: 



4 Data and refinement statistics

Xtriage (Phenix) and EDS were not executed - this section is therefore incomplete.

Property	Value	Source
Space group	P 21 21 21	Depositor
Cell constants a, b, c, α , β , γ	44.57Å 96.62Å 31.34Å 90.00° 90.00° 90.00°	Depositor
Resolution (Å)	(Not available) – 2.00	Depositor
% Data completeness (in resolution range)	(Not available) ((Not available)-2.00)	Depositor
R_{merge}	(Not available)	Depositor
R_{sym}	(Not available)	Depositor
Refinement program	unknown	Depositor
R, R_{free}	0.142 , (Not available)	Depositor
Estimated twinning fraction	No twinning to report.	Xtriage
Total number of atoms	2620	wwPDB-VP
Average B, all atoms (Å ²)	17.0	wwPDB-VP

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, CYN

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	0.91	0/1290	1.52	15/1735 (0.9%)

There are no bond length outliers.

All (15) bond angle outliers are listed below:

Mol	Chain	Res	Type	Atoms	Z	Observed(°)	Ideal(°)
1	A	71	ARG	NE-CZ-NH1	14.44	127.52	120.30
1	A	20	ARG	NE-CZ-NH2	8.47	124.53	120.30
1	A	112	ASP	CB-CG-OD1	7.75	125.28	118.30
1	A	76	ARG	NE-CZ-NH2	7.61	124.11	120.30
1	A	71	ARG	NE-CZ-NH2	-6.88	116.86	120.30
1	A	76	ARG	CD-NE-CZ	6.59	132.82	123.60
1	A	88	MET	CG-SD-CE	6.56	110.69	100.20
1	A	29[B]	ASP	CB-CG-OD1	6.55	124.19	118.30
1	A	125	ASP	CB-CG-OD1	6.46	124.11	118.30
1	A	146	ARG	NE-CZ-NH1	5.96	123.28	120.30
1	A	146	ARG	CD-NE-CZ	5.45	131.23	123.60
1	A	20	ARG	CD-NE-CZ	-5.22	116.29	123.60
1	A	89	ASP	CB-CG-OD2	-5.16	113.66	118.30
1	A	8	VAL	O-C-N	5.05	130.78	122.70
1	A	20	ARG	NE-CZ-NH1	-5.03	117.79	120.30

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	1205	1155	1226	60	4
2	A	2	0	0	1	0
3	A	43	0	30	3	0
4	A	215	0	0	20	2
All	All	1465	1155	1256	61	4

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 24.

All (61) 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:A:54[A]:LYS:HE3	4:A:255:HOH:O	1.25	1.25
1:A:18[B]:LYS:HE2	4:A:190:HOH:O	1.30	1.23
1:A:99[B]:ARG:HD3	4:A:174:HOH:O	1.64	0.98
1:A:24:ALA:HB3	1:A:25:PRO:HD3	1.51	0.91
1:A:134:PHE:CZ	1:A:138:MET:HE2	2.08	0.88
1:A:62:ASP:O	1:A:66:LYS:HG3	1.76	0.85
1:A:54[A]:LYS:HE2	1:A:69:ASP:HB3	1.61	0.82
1:A:93[A]:LYS:HD2	4:A:357:HOH:O	1.80	0.82
1:A:63[B]:GLU:OE1	4:A:215:HOH:O	2.05	0.75
1:A:90:ASP:OD1	4:A:265:HOH:O	2.06	0.73
1:A:126:THR:OG1	4:A:358:HOH:O	2.09	0.70
1:A:24:ALA:HB3	1:A:25:PRO:CD	2.21	0.70
1:A:38[A]:LEU:HD12	1:A:74:ALA:HB2	1.76	0.68
1:A:99[A]:ARG:NH2	4:A:168:HOH:O	2.21	0.68
1:A:112:ASP:OD1	1:A:114[A]:GLU:HG2	1.94	0.67
1:A:136:LYS:O	1:A:140[B]:MET:HG3	1.95	0.66
1:A:136:LYS:O	1:A:140[A]:MET:HG3	1.95	0.66
1:A:75:GLU:OE1	4:A:365:HOH:O	2.14	0.66
1:A:54[A]:LYS:HD3	4:A:253:HOH:O	1.95	0.65
1:A:134:PHE:CZ	1:A:138:MET:CE	2.80	0.64
1:A:38[B]:LEU:HD23	1:A:70:VAL:HG13	1.81	0.63
1:A:134:PHE:CE2	1:A:138:MET:HE3	2.34	0.62
1:A:134:PHE:HZ	1:A:138:MET:HE2	1.65	0.60
1:A:38[A]:LEU:CD1	1:A:74:ALA:HB2	2.32	0.59
1:A:134:PHE:CE2	1:A:138:MET:CE	2.86	0.59
1:A:54[A]:LYS:CE	4:A:255:HOH:O	2.05	0.58
1:A:93[A]:LYS:HE3	4:A:357:HOH:O	2.05	0.57

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Atom-1	Atom-2	Interatomic distance (Å)	Clash overlap (Å)
1:A:46:PRO:HB3	4:A:366:HOH:O	2.03	0.57
1:A:100:ASN:HD21	1:A:104:LYS:NZ	2.04	0.56
1:A:50:GLU:CG	4:A:235:HOH:O	2.54	0.55
1:A:97[A]:LYS:HD2	4:A:171:HOH:O	2.07	0.55
1:A:54[A]:LYS:HE2	1:A:69:ASP:CB	2.34	0.54
1:A:36:ASP:OD2	1:A:40:LYS:HE3	2.08	0.54
1:A:111:VAL:HG11	3:A:151:HEM:CHD	2.40	0.52
1:A:18[B]:LYS:HE3	1:A:131:ASP:OD1	2.11	0.51
1:A:93[A]:LYS:CD	4:A:357:HOH:O	2.45	0.51
1:A:123:ILE:HG21	1:A:138:MET:HE1	1.92	0.50
1:A:134:PHE:HE2	1:A:138:MET:HE3	1.76	0.50
1:A:62:ASP:O	1:A:66:LYS:CG	2.56	0.50
1:A:93[A]:LYS:CE	4:A:357:HOH:O	2.60	0.48
1:A:105:HIS:HA	1:A:109:PHE:CD1	2.48	0.48
1:A:14:ALA:O	1:A:18[B]:LYS:CG	2.62	0.48
1:A:24:ALA:CB	1:A:25:PRO:CD	2.88	0.47
1:A:14:ALA:O	1:A:18[B]:LYS:HG3	2.15	0.47
1:A:100:ASN:HD21	1:A:104:LYS:HZ1	1.61	0.47
3:A:151:HEM:HAA2	4:A:208:HOH:O	2.15	0.45
1:A:11:LEU:HD22	1:A:140[A]:MET:HE1	1.98	0.44
1:A:111:VAL:HG11	3:A:151:HEM:HHD	1.98	0.44
1:A:27:TYR:O	1:A:30[A]:TYR:HD1	2.00	0.44
1:A:52:PHE:HB3	1:A:55:PHE:CD2	2.53	0.44
1:A:36:ASP:O	1:A:40:LYS:HG3	2.18	0.44
1:A:100:ASN:ND2	1:A:104:LYS:NZ	2.66	0.43
1:A:37:ILE:HG23	1:A:122:VAL:HG12	2.01	0.43
1:A:100:ASN:ND2	1:A:104:LYS:HZ2	2.17	0.43
1:A:38[A]:LEU:HD21	1:A:77:ILE:CD1	2.48	0.42
1:A:77:ILE:HD11	2:A:150:CYN:N	2.35	0.41
1:A:50:GLU:HG2	4:A:235:HOH:O	2.20	0.41
1:A:112:ASP:OD2	1:A:114[A]:GLU:OE2	2.37	0.41
1:A:63[B]:GLU:HG2	4:A:244:HOH:O	2.20	0.41
1:A:105:HIS:HA	1:A:109:PHE:HD1	1.86	0.40

All (4) 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:99[A]:ARG:HH22	4:A:194:HOH:O[1_556]	1.29	0.31
1:A:31:GLU:OE1	1:A:40:LYS:HZ3[2_565]	1.40	0.20

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Atom-1	Atom-2	Interatomic distance (Å)	Clash overlap (Å)
1:A:91:THR:HG1	1:A:107[B]:LYS:NZ[4_555]	1.55	0.05
1:A:99[A]:ARG:NH2	4:A:194:HOH:O[1_556]	2.17	0.03

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	158/150 (105%)	154 (98%)	4 (2%)	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	135/123 (110%)	127 (94%)	8 (6%)	19 15

All (8) residues with a non-rotameric sidechain are listed below:

Mol	Chain	Res	Type
1	A	11	LEU
1	A	36	ASP
1	A	67	SER
1	A	71	ARG
1	A	107[A]	LYS
1	A	107[B]	LYS

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Mol	Chain	Res	Type
1	A	109	PHE
1	A	137	LEU

Some sidechains can be flipped to improve hydrogen bonding and reduce clashes. All (2) such sidechains are listed below:

Mol	Chain	Res	Type
1	A	79	ASN
1	A	100	ASN

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](#)

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	$\# Z > 2$
3	HEM	A	151	1,2	27,50,50	2.03	5 (18%)	17,82,82	2.55	8 (47%)
2	CYN	A	150	3	0,1,1	0.00	-	-		

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
3	HEM	A	151	1,2	-	0/6/54/54	-

All (5) bond length outliers are listed below:

Mol	Chain	Res	Type	Atoms	Z	Observed(Å)	Ideal(Å)
3	A	151	HEM	C3C-C2C	-5.10	1.33	1.40
3	A	151	HEM	C3B-C2B	-4.24	1.34	1.40
3	A	151	HEM	C3C-CAC	3.91	1.55	1.47
3	A	151	HEM	C3B-CAB	2.80	1.53	1.47
3	A	151	HEM	CAA-C2A	2.55	1.55	1.52

All (8) bond angle outliers are listed below:

Mol	Chain	Res	Type	Atoms	Z	Observed(°)	Ideal(°)
3	A	151	HEM	CMA-C3A-C4A	-5.99	119.25	128.46
3	A	151	HEM	CMA-C3A-C2A	4.39	133.22	124.94
3	A	151	HEM	CMC-C2C-C3C	3.32	130.89	124.68
3	A	151	HEM	CAA-CBA-CGA	3.30	118.20	112.67
3	A	151	HEM	CMD-C2D-C1D	-3.22	123.52	128.46
3	A	151	HEM	C4C-C3C-C2C	2.81	108.86	106.90
3	A	151	HEM	CMD-C2D-C3D	2.44	129.54	124.94
3	A	151	HEM	CMB-C2B-C3B	2.01	128.44	124.68

There are no chirality outliers.

There are no torsion outliers.

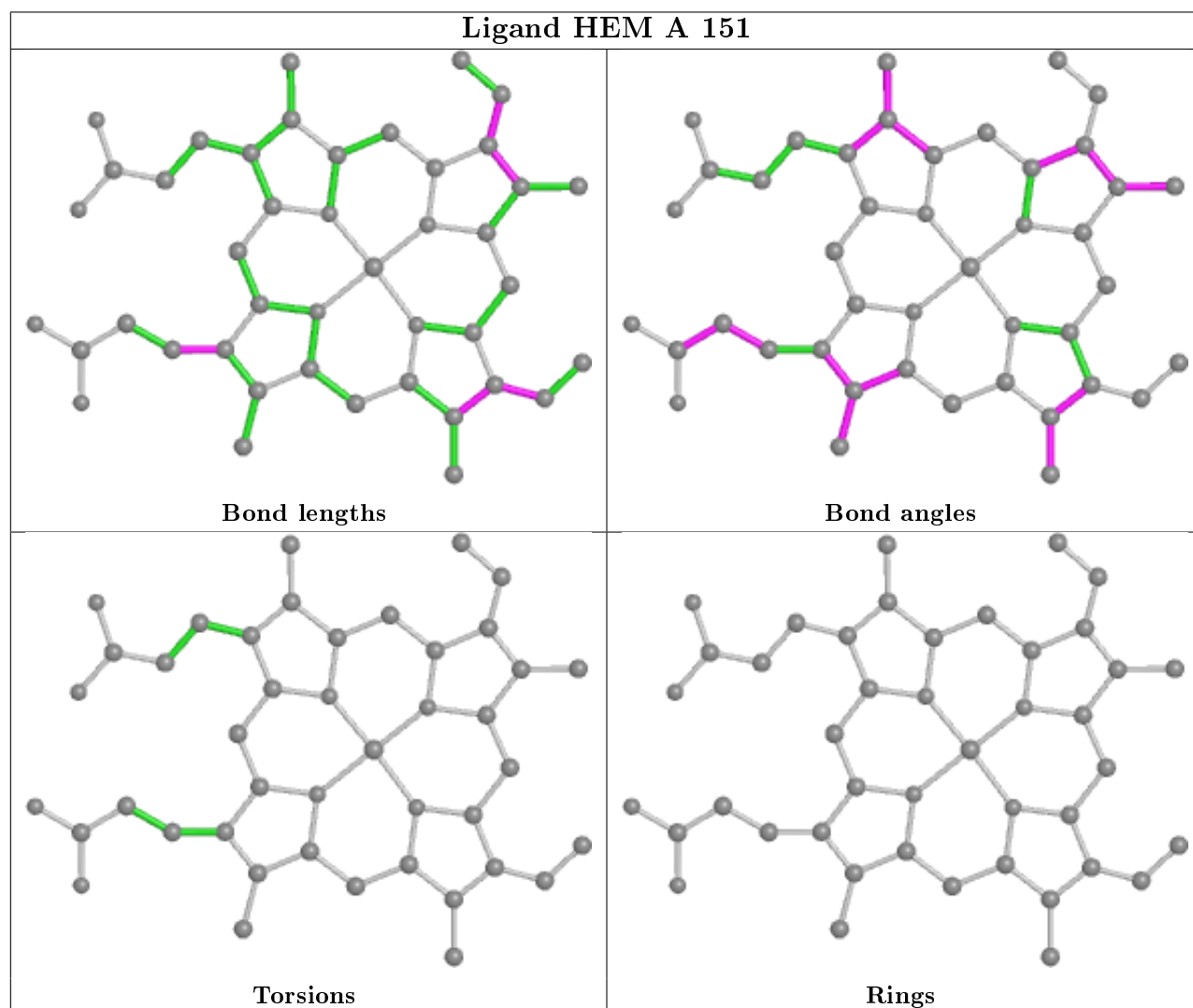
There are no ring outliers.

2 monomers are involved in 4 short contacts:

Mol	Chain	Res	Type	Clashes	Symm-Clashes
3	A	151	HEM	3	0
2	A	150	CYN	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 than 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.



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 ⓘ

6.1 Protein, DNA and RNA chains ⓘ

EDS was not executed - this section is therefore empty.

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

EDS was not executed - this section is therefore empty.

6.3 Carbohydrates ⓘ

EDS was not executed - this section is therefore empty.

6.4 Ligands ⓘ

EDS was not executed - this section is therefore empty.

6.5 Other polymers ⓘ

EDS was not executed - this section is therefore empty.