



wwPDB X-ray Structure Validation Summary Report ⓘ

Oct 16, 2023 – 10:50 PM EDT

PDB ID : 1SI4
Title : Crystal structure of Human hemoglobin A2 (in R2 state) at 2.2 Å resolution
Authors : Sen, U.; Dasgupta, J.; Choudhury, D.; Datta, P.; Chakrabarti, A.;
Chakrabarty, S.B.; Chakrabarty, A.; Dattagupta, J.K.
Deposited on : 2004-02-27
Resolution : 2.20 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 ⓘ 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 ⓘ](#)) were used in the production of this report:

MolProbity : 4.02b-467
Mogul : 1.8.5 (274361), CSD as541be (2020)
Xtrriage (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) : 2.36

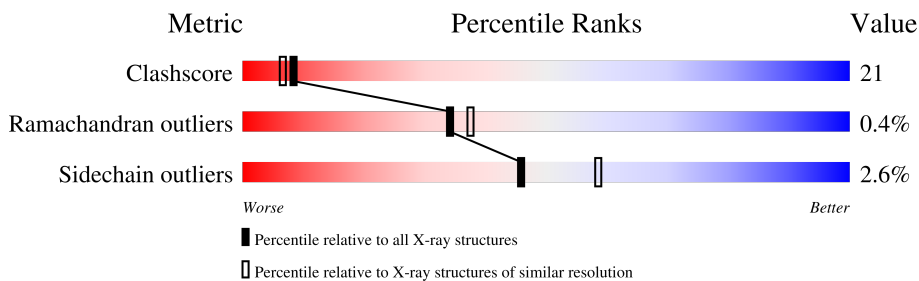
1 Overall quality at a glance

The following experimental techniques were used to determine the structure:

X-RAY DIFFRACTION

The reported resolution of this entry is 2.20 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	5594 (2.20-2.20)
Ramachandran outliers	138981	5503 (2.20-2.20)
Sidechain outliers	138945	5504 (2.20-2.20)

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 $\leq 5\%$.

Note EDS was not executed.

Mol	Chain	Length	Quality of chain
1	A	141	
1	C	141	
2	B	146	
2	D	146	

2 Entry composition [i](#)

There are 5 unique types of molecules in this entry. The entry contains 5222 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.

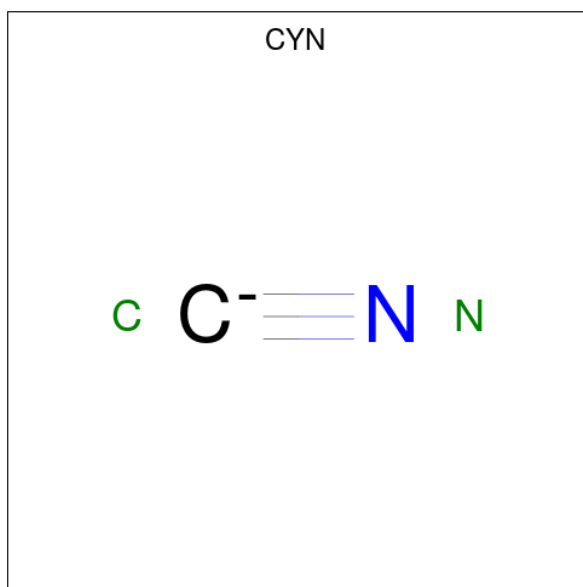
- Molecule 1 is a protein called Hemoglobin alpha chain.

Mol	Chain	Residues	Atoms					ZeroOcc	AltConf	Trace
			Total	C	N	O	S			
1	A	141	1065	682	186	194	3	0	0	0
1	C	141	1069	685	187	194	3	0	0	0

- Molecule 2 is a protein called Hemoglobin delta chain.

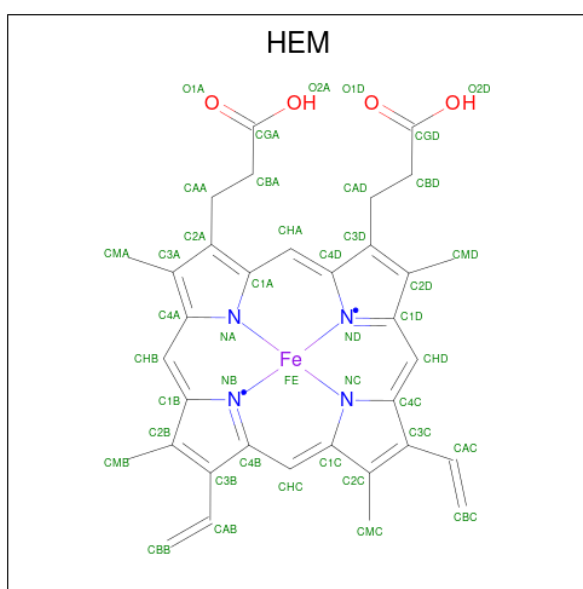
Mol	Chain	Residues	Atoms					ZeroOcc	AltConf	Trace
			Total	C	N	O	S			
2	B	146	1121	718	197	202	4	0	0	0
2	D	146	1124	721	198	201	4	0	0	0

- Molecule 3 is CYANIDE ION (three-letter code: CYN) (formula: CN).



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

- Molecule 4 is PROTOPORPHYRIN IX CONTAINING FE (three-letter code: HEM) (formula: $C_{34}H_{32}FeN_4O_4$).



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

- Molecule 5 is water.

Mol	Chain	Residues	Atoms	ZeroOcc	AltConf
5	A	136	Total O 136 136	0	0

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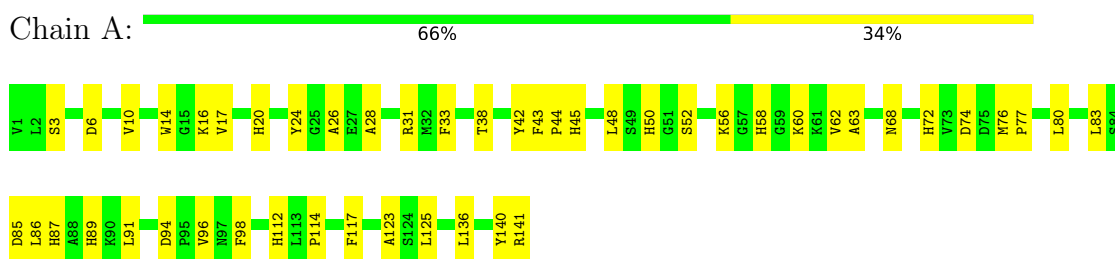
Mol	Chain	Residues	Atoms		ZeroOcc	AltConf
5	B	190	Total 190	O 190	0	0
5	C	140	Total 140	O 140	0	0
5	D	197	Total 197	O 197	0	0

3 Residue-property plots

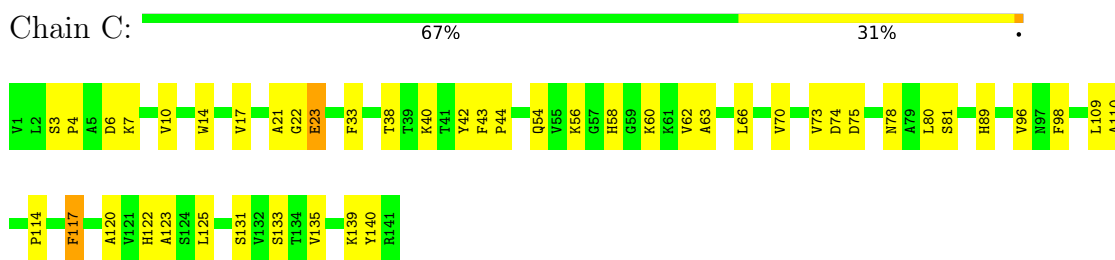
These plots are drawn for all protein, RNA, DNA and oligosaccharide chains in the entry. The first graphic for a chain summarises the proportions of the various outlier classes displayed in the second graphic. The second graphic shows the sequence view annotated by issues in geometry. Residues are color-coded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

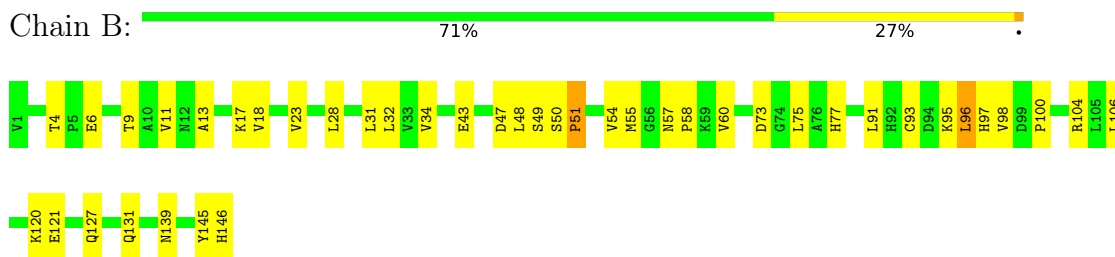
- Molecule 1: Hemoglobin alpha chain



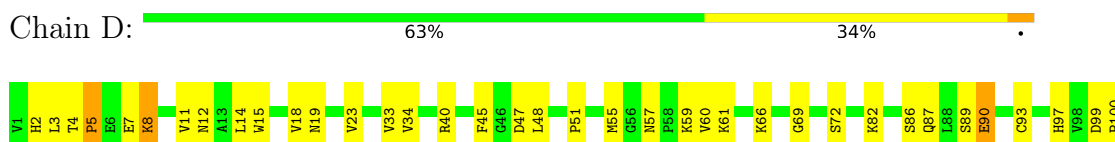
- Molecule 1: Hemoglobin alpha chain



- Molecule 2: Hemoglobin delta chain



- Molecule 2: Hemoglobin delta chain



E101	M102	F103	R104	L105	V109	R116	Q125	K132	V133	V137	A138	M139	A140	L141	A142	H143	K144	Y145	H146
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4 Data and refinement statistics

Xtrriage (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	60.45Å 88.19Å 104.59Å 90.00° 90.00° 90.00°	Depositor
Resolution (Å)	14.96 – 2.20	Depositor
% Data completeness (in resolution range)	97.9 (14.96-2.20)	Depositor
R_{merge}	0.07	Depositor
R_{sym}	(Not available)	Depositor
Refinement program	CNS 1.0	Depositor
R, R_{free}	0.218 , 0.258	Depositor
Estimated twinning fraction	No twinning to report.	Xtrriage
Total number of atoms	5222	wwPDB-VP
Average B, all atoms (Å ²)	34.0	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: CYN, HEM

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	0.45	0/1093	0.64	0/1487
1	C	0.41	0/1097	0.63	1/1491 (0.1%)
2	B	0.47	0/1148	0.67	0/1556
2	D	0.49	0/1151	0.67	0/1559
All	All	0.46	0/4489	0.65	1/6093 (0.0%)

There are no bond length outliers.

All (1) bond angle outliers are listed below:

Mol	Chain	Res	Type	Atoms	Z	Observed(°)	Ideal(°)
1	C	23	GLU	N-CA-C	-6.43	93.65	111.00

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	1065	0	1062	49	0
1	C	1069	0	1073	52	0
2	B	1121	0	1112	34	0
2	D	1124	0	1120	70	0
3	A	2	0	0	1	0
3	B	2	0	0	0	0

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Mol	Chain	Non-H	H(model)	H(added)	Clashes	Symm-Clashes
3	C	2	0	0	0	0
3	D	2	0	0	0	0
4	A	43	0	30	1	0
4	B	43	0	30	0	0
4	C	43	0	30	0	0
4	D	43	0	30	1	0
5	A	136	0	0	23	0
5	B	190	0	0	10	0
5	C	140	0	0	16	0
5	D	197	0	0	27	0
All	All	5222	0	4487	189	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 21.

The worst 5 of 189 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:60:VAL:HG23	5:B:1659:HOH:O	1.48	1.11
1:A:31:ARG:HD2	5:A:1609:HOH:O	1.55	1.06
2:B:95:LYS:HD3	2:B:96:LEU:HD13	1.41	1.03
1:A:10:VAL:HG22	5:A:1593:HOH:O	1.62	0.99
2:B:28:LEU:HG	5:B:1653:HOH:O	1.63	0.98

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	139/141 (99%)	131 (94%)	8 (6%)	0	100	100
1	C	139/141 (99%)	133 (96%)	5 (4%)	1 (1%)	22	22

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Mol	Chain	Analysed	Favoured	Allowed	Outliers	Percentiles	
2	B	144/146 (99%)	142 (99%)	2 (1%)	0	100	100
2	D	144/146 (99%)	132 (92%)	11 (8%)	1 (1%)	22	22
All	All	566/574 (99%)	538 (95%)	26 (5%)	2 (0%)	34	37

All (2) Ramachandran outliers are listed below:

Mol	Chain	Res	Type
2	D	19	ASN
1	C	117	PHE

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	112/113 (99%)	109 (97%)	3 (3%)	44	57
1	C	113/113 (100%)	112 (99%)	1 (1%)	78	88
2	B	117/118 (99%)	114 (97%)	3 (3%)	46	58
2	D	117/118 (99%)	112 (96%)	5 (4%)	29	36
All	All	459/462 (99%)	447 (97%)	12 (3%)	46	58

5 of 12 residues with a non-rotameric sidechain are listed below:

Mol	Chain	Res	Type
2	D	5	PRO
2	D	8	LYS
2	D	141	LEU
2	D	90	GLU
2	B	43	GLU

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

Mol	Chain	Res	Type
1	C	9	ASN
2	D	108	ASN
1	C	50	HIS
2	D	125	GLN
1	C	89	HIS

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](#)

8 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
4	HEM	A	142	3,1	41,50,50	1.35	5 (12%)	45,82,82	1.63	7 (15%)
3	CYN	B	148	4	0,1,1	-	-	-		
3	CYN	D	148	4	0,1,1	-	-	-		
4	HEM	D	147	3,2	41,50,50	1.45	7 (17%)	45,82,82	1.56	8 (17%)
3	CYN	A	143	4	0,1,1	-	-	-		
3	CYN	C	143	4	0,1,1	-	-	-		
4	HEM	B	147	3,2	41,50,50	1.33	2 (4%)	45,82,82	1.44	8 (17%)
4	HEM	C	142	3,1	41,50,50	1.43	5 (12%)	45,82,82	1.61	7 (15%)

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
4	HEM	A	142	3,1	-	4/12/54/54	-
4	HEM	C	142	3,1	-	5/12/54/54	-
4	HEM	D	147	3,2	-	7/12/54/54	-
4	HEM	B	147	3,2	-	7/12/54/54	-

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

Mol	Chain	Res	Type	Atoms	Z	Observed(Å)	Ideal(Å)
4	B	147	HEM	C3C-CAC	-4.51	1.38	1.47
4	D	147	HEM	C3C-CAC	-4.36	1.38	1.47
4	C	142	HEM	C3C-CAC	-4.22	1.39	1.47
4	C	142	HEM	CBB-CAB	3.87	1.49	1.30
4	A	142	HEM	CBB-CAB	3.72	1.48	1.30

The worst 5 of 30 bond angle outliers are listed below:

Mol	Chain	Res	Type	Atoms	Z	Observed(°)	Ideal(°)
4	C	142	HEM	CBA-CAA-C2A	6.21	123.22	112.62
4	A	142	HEM	CBA-CAA-C2A	6.20	123.19	112.62
4	D	147	HEM	CBA-CAA-C2A	5.70	122.35	112.62
4	B	147	HEM	CBA-CAA-C2A	4.21	119.81	112.62
4	A	142	HEM	C4C-CHD-C1D	3.61	127.32	122.56

There are no chirality outliers.

5 of 23 torsion outliers are listed below:

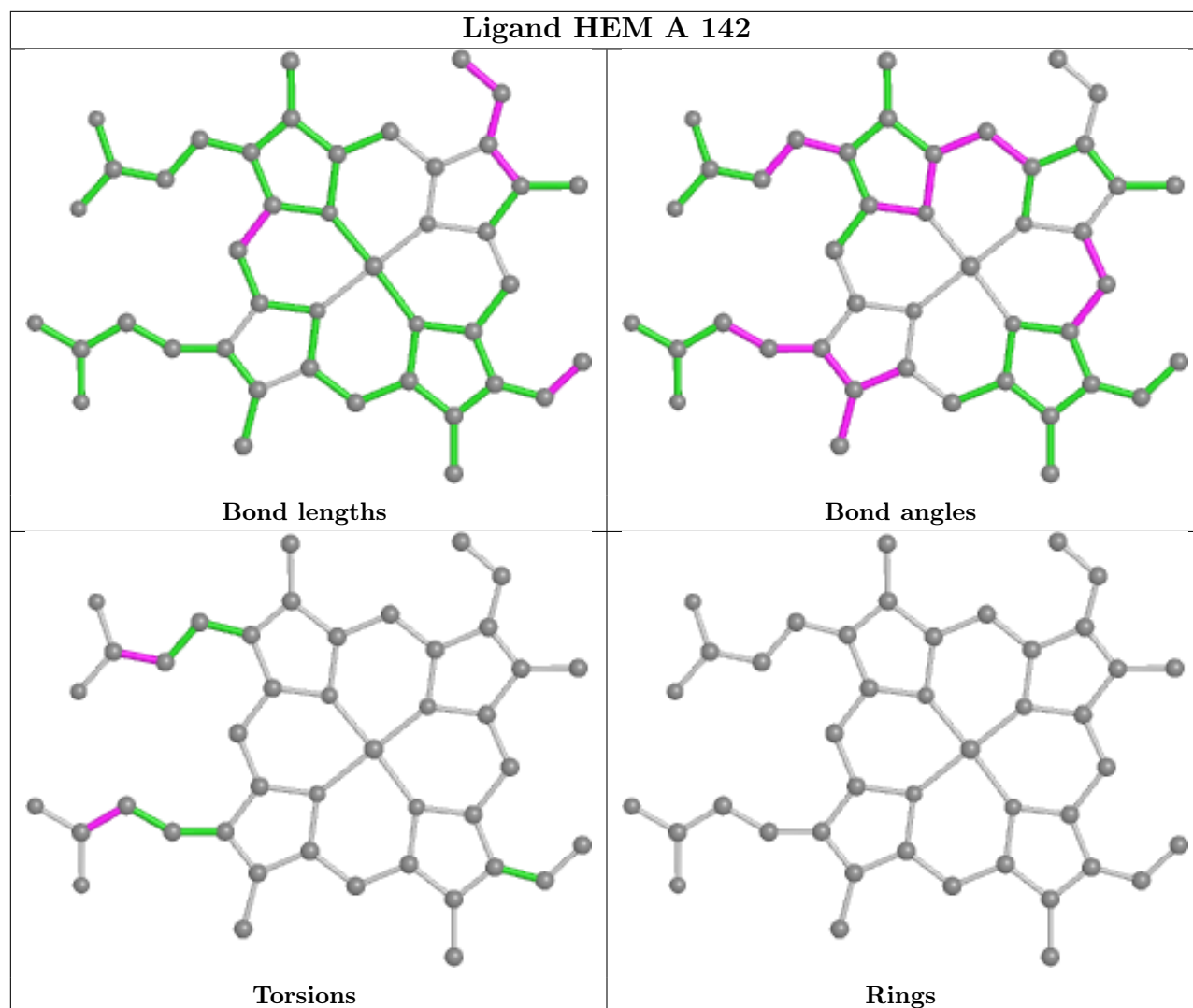
Mol	Chain	Res	Type	Atoms
4	D	147	HEM	C2B-C3B-CAB-CBB
4	D	147	HEM	C4B-C3B-CAB-CBB
4	B	147	HEM	C2A-CAA-CBA-CGA
4	B	147	HEM	C2B-C3B-CAB-CBB
4	B	147	HEM	C4B-C3B-CAB-CBB

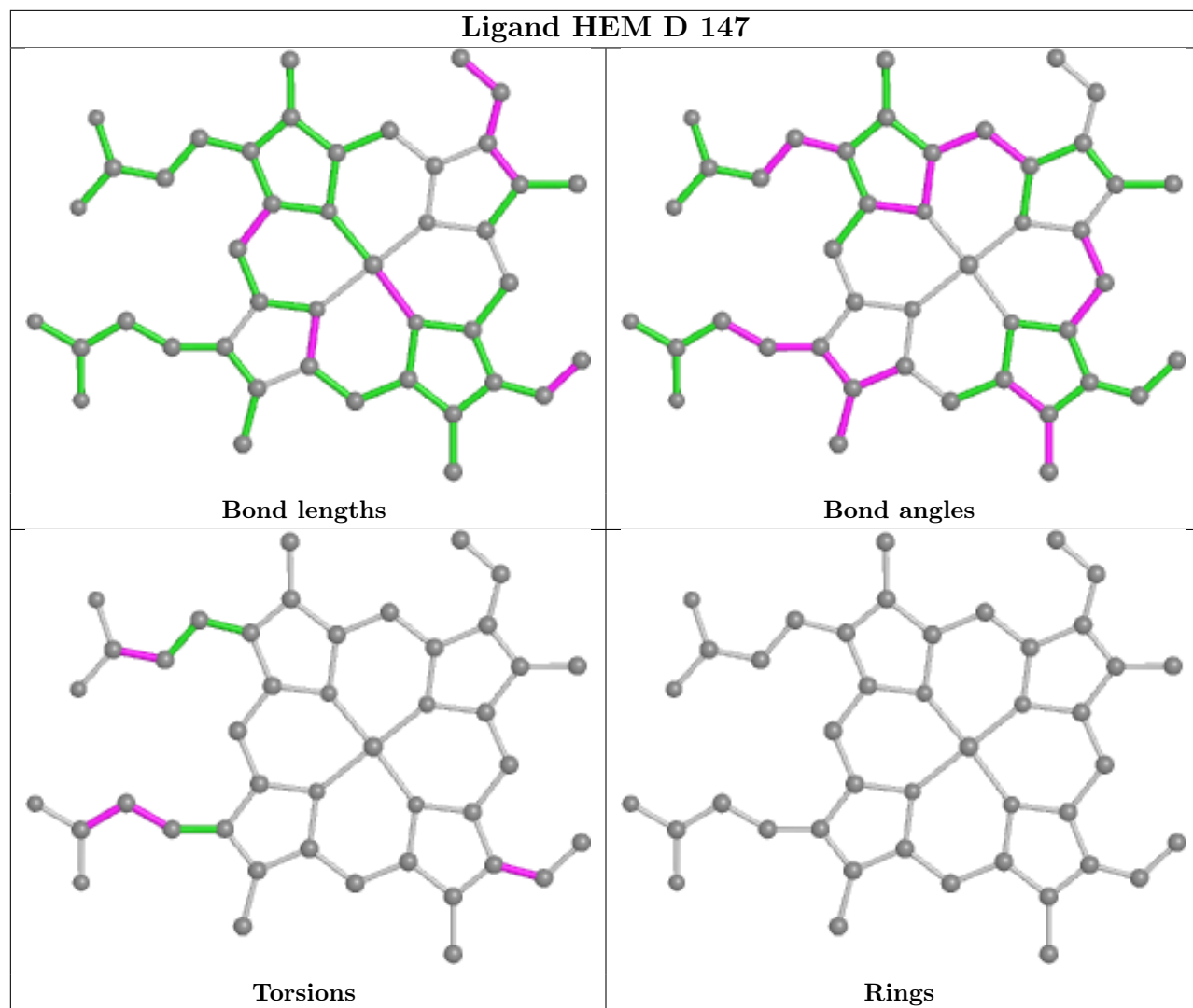
There are no ring outliers.

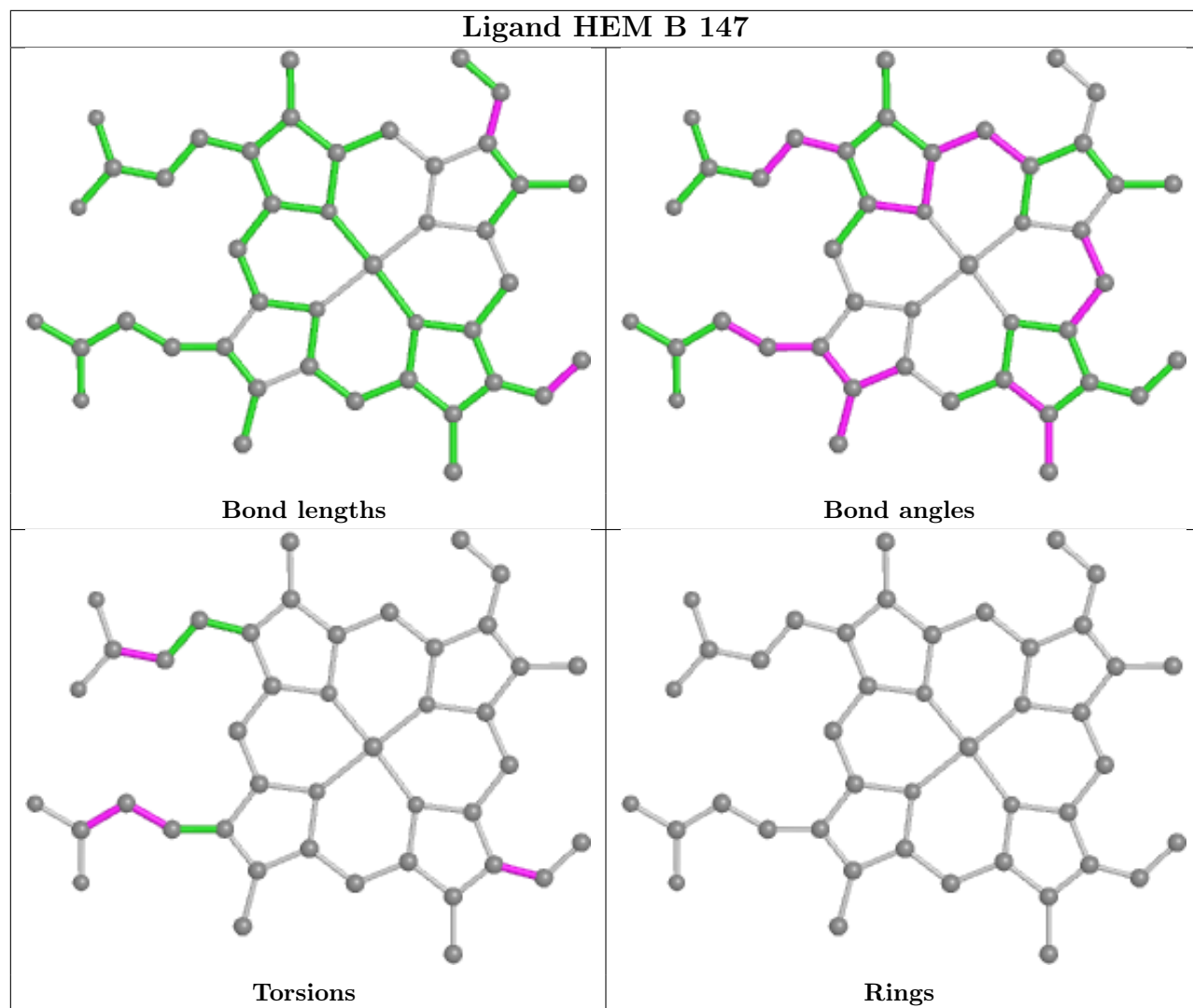
3 monomers are involved in 3 short contacts:

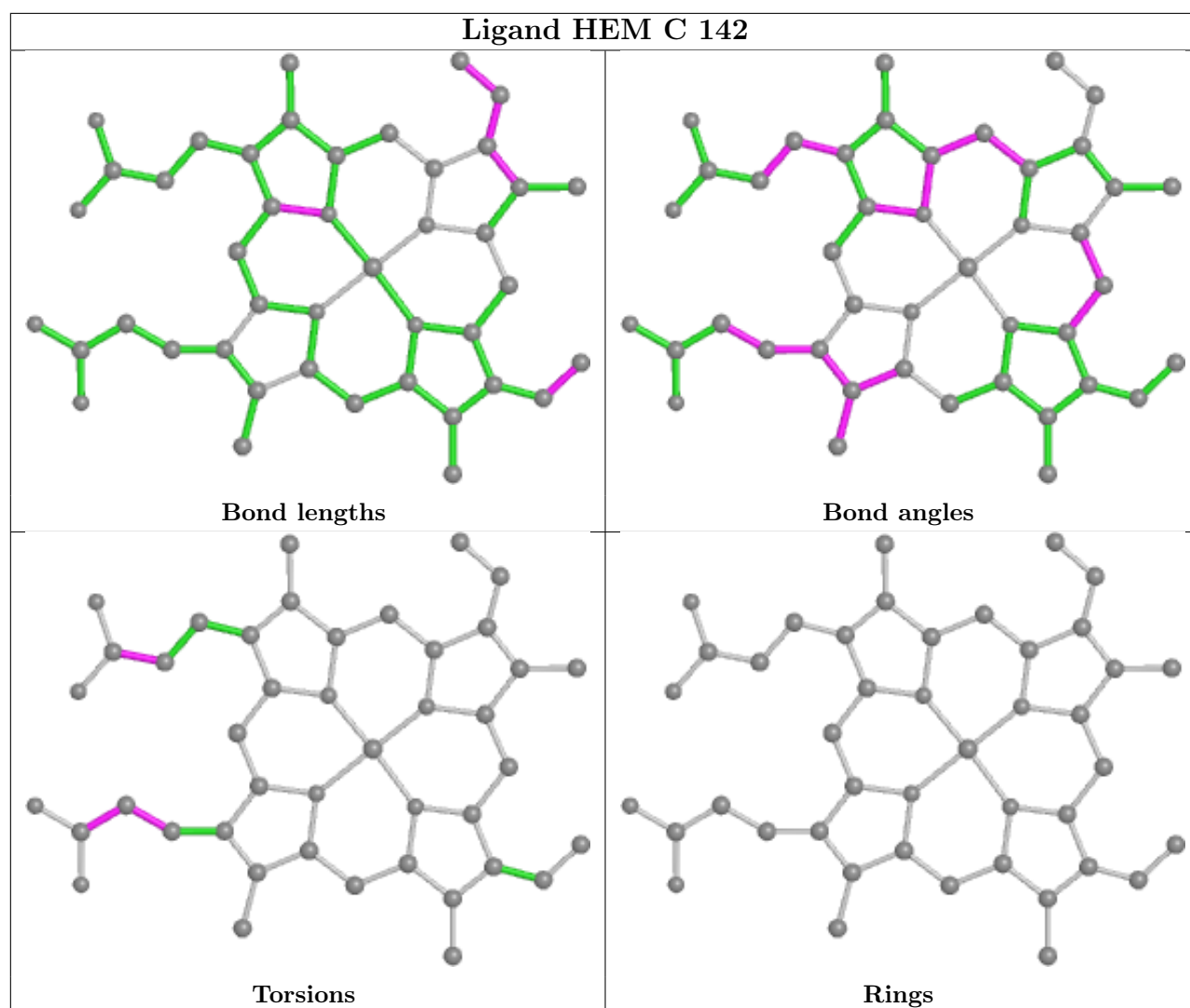
Mol	Chain	Res	Type	Clashes	Symm-Clashes
4	A	142	HEM	1	0
4	D	147	HEM	1	0
3	A	143	CYN	1	0

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.