



Full wwPDB X-ray Structure Validation Report ⓘ

May 16, 2020 – 12:04 pm BST

PDB ID : 1V4X
Title : Crystal structure of bluefin tuna hemoglobin deoxy form at pH5.0
Authors : Yokoyama, T.; Chong, K.T.; Miyazaki, Y.; Nakatsukasa, T.; Unzai, S.;
Miyazaki, G.; Morimoto, H.; Jeremy, R.H.T.; Park, S.Y.
Deposited on : 2003-11-19
Resolution : 1.60 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

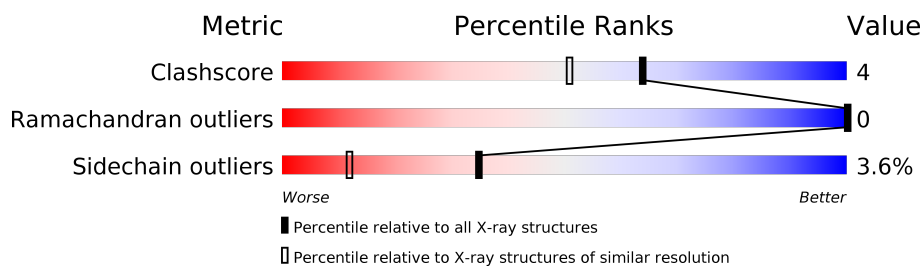
1 Overall quality at a glance

The following experimental techniques were used to determine the structure:

X-RAY DIFFRACTION

The reported resolution of this entry is 1.60 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	3665 (1.60-1.60)
Ramachandran outliers	138981	3564 (1.60-1.60)
Sidechain outliers	138945	3563 (1.60-1.60)

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	144	 88% 12% .
1	C	144	 87% 13% .
2	B	146	 91% 8% .
2	D	146	 86% 12% .

2 Entry composition [i](#)

There are 4 unique types of molecules in this entry. The entry contains 4916 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
1	A	144	Total	C	N	O	S	0	0	0
			1088	699	184	199	6			
1	C	144	Total	C	N	O	S	0	0	0
			1088	699	184	199	6			

- Molecule 2 is a protein called hemoglobin beta chain.

Mol	Chain	Residues	Atoms					ZeroOcc	AltConf	Trace
2	B	146	Total	C	N	O	S	0	0	0
			1143	733	197	209	4			
2	D	146	Total	C	N	O	S	0	0	0
			1143	733	197	209	4			

- 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
3	B	1	Total 43	C 34	Fe 1	N 4	O 4	0	0
3	C	1	Total 43	C 34	Fe 1	N 4	O 4	0	0
3	D	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	61	Total 61	O 61	0	0
4	B	103	Total 103	O 103	0	0
4	C	72	Total 72	O 72	0	0
4	D	46	Total 46	O 46	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.

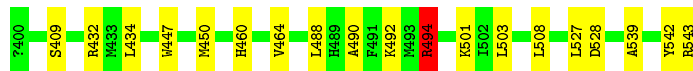
- Molecule 1: hemoglobin alpha chain

Chain A: 



- Molecule 1: hemoglobin alpha chain

Chain C: 




- Molecule 2: hemoglobin beta chain

Chain B: 



- Molecule 2: hemoglobin beta chain

Chain D: 



4 Data and refinement statistics

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

Property	Value	Source
Space group	P 1 21 1	Depositor
Cell constants a, b, c, α , β , γ	56.98 Å 60.54 Å 80.64 Å 90.00° 95.12° 90.00°	Depositor
Resolution (Å)	19.73 – 1.60	Depositor
% Data completeness (in resolution range)	100.0 (19.73-1.60)	Depositor
R_{merge}	0.07	Depositor
R_{sym}	(Not available)	Depositor
Refinement program	REFMAC 5.1.22	Depositor
R, R_{free}	0.204 , 0.250	Depositor
Estimated twinning fraction	No twinning to report.	Xtriage
Total number of atoms	4916	wwPDB-VP
Average B, all atoms (Å ²)	14.0	wwPDB-VP

5 Model quality

5.1 Standard geometry

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

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	0/1110	0.91	4/1499 (0.3%)
1	C	0.86	0/1110	0.92	4/1499 (0.3%)
2	B	0.86	0/1168	0.94	6/1585 (0.4%)
2	D	0.83	0/1168	0.88	5/1585 (0.3%)
All	All	0.85	0/4556	0.91	19/6168 (0.3%)

There are no bond length outliers.

All (19) bond angle outliers are listed below:

Mol	Chain	Res	Type	Atoms	Z	Observed(°)	Ideal(°)
1	A	76	ASP	CB-CG-OD2	8.07	125.56	118.30
1	A	49	ASP	CB-CG-OD2	7.37	124.93	118.30
2	B	272	ASP	CB-CG-OD2	7.27	124.85	118.30
2	B	294	ASP	CB-CG-OD2	7.16	124.74	118.30
1	C	494	ARG	NE-CZ-NH2	-7.06	116.77	120.30
2	B	306	LEU	CB-CG-CD2	6.91	122.75	111.00
2	D	652	ASP	CB-CG-OD2	6.39	124.05	118.30
2	D	708	ASP	CB-CG-OD2	6.28	123.96	118.30
2	B	301	ASP	CB-CG-OD2	6.21	123.89	118.30
1	C	528	ASP	CB-CG-OD2	5.95	123.66	118.30
1	C	488	LEU	CA-CB-CG	5.89	128.85	115.30
2	D	694	ASP	CB-CG-OD2	5.77	123.49	118.30
2	B	268	LEU	CB-CG-CD2	5.73	120.73	111.00
1	C	543	ARG	NE-CZ-NH1	-5.63	117.49	120.30
1	A	128	ASP	CB-CG-OD2	5.58	123.32	118.30
2	B	320	ASP	CB-CG-OD2	5.57	123.31	118.30
1	A	5	ASP	CB-CG-OD2	5.31	123.08	118.30
2	D	741	LEU	CB-CG-CD1	-5.30	101.98	111.00
2	D	743	ARG	NE-CZ-NH2	-5.21	117.69	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	1088	0	1120	15	0
1	C	1088	0	1120	13	0
2	B	1143	0	1132	6	0
2	D	1143	0	1132	12	0
3	A	43	0	30	4	0
3	B	43	0	30	1	0
3	C	43	0	30	2	0
3	D	43	0	30	1	0
4	A	61	0	0	0	0
4	B	103	0	0	0	0
4	C	72	0	0	0	0
4	D	46	0	0	0	0
All	All	4916	0	4624	39	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 4.

All (39) 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:C:490:ALA:O	1:C:494:ARG:HD3	1.68	0.92
1:C:432:ARG:HH11	2:D:727:GLN:HE21	1.38	0.72
1:C:432:ARG:HD3	2:D:727:GLN:HE22	1.59	0.68
1:A:32:ARG:HH11	2:B:327:GLN:HE21	1.44	0.66
1:A:47:TRP:HH2	1:A:60:HIS:HB2	1.66	0.61
1:A:47:TRP:CH2	1:A:60:HIS:HB2	2.36	0.60
1:C:447:TRP:CD2	1:C:460:HIS:HE1	2.19	0.60
1:A:47:TRP:HH2	1:A:60:HIS:CB	2.16	0.58
1:C:432:ARG:HH11	2:D:727:GLN:NE2	2.03	0.55
1:A:60:HIS:CE1	3:A:144:HEM:C4D	2.94	0.55
2:D:603:TRP:CZ3	2:D:732:LYS:HD3	2.43	0.54

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Atom-1	Atom-2	Interatomic distance (Å)	Clash overlap (Å)
1:A:60:HIS:HE1	3:A:144:HEM:CHA	2.23	0.52
1:A:32:ARG:HH11	2:B:327:GLN:NE2	2.07	0.52
1:C:464:VAL:HG11	1:C:503:LEU:HD21	1.92	0.51
1:A:21:SER:O	1:A:25:ILE:HG13	2.11	0.51
1:A:26:GLY:CA	1:A:65:MET:HG2	2.41	0.50
1:C:490:ALA:O	1:C:494:ARG:CD	2.51	0.50
1:A:60:HIS:HE1	3:A:144:HEM:C4D	2.30	0.49
1:C:432:ARG:HD3	2:D:727:GLN:NE2	2.26	0.49
2:D:601:VAL:CG1	2:D:732:LYS:HE2	2.43	0.48
2:D:641:TYR:CE1	2:D:698:VAL:HA	2.49	0.48
1:A:8:LYS:HG2	1:A:75:ILE:HG12	1.97	0.47
1:A:85:LEU:HD21	3:A:144:HEM:HMA3	1.96	0.46
1:C:508:LEU:HD23	1:C:527:LEU:HD23	1.98	0.45
1:C:539:ALA:HA	1:C:542:TYR:CD1	2.53	0.44
2:D:732:LYS:O	2:D:736:VAL:HG23	2.18	0.44
2:D:663:HIS:HE1	3:D:747:HEM:C4D	2.36	0.43
1:C:447:TRP:CH2	3:C:544:HEM:HBD1	2.54	0.43
2:D:667:VAL:HG11	2:D:706:LEU:HD11	2.01	0.43
1:A:32:ARG:HD3	2:B:327:GLN:HE22	1.83	0.43
2:B:238:THR:HB	3:B:347:HEM:HBC1	2.00	0.43
2:B:273:ARG:HG2	2:B:285:TYR:OH	2.18	0.42
1:C:434:LEU:HD13	1:C:450:MET:HB3	2.02	0.42
2:D:601:VAL:HG11	2:D:732:LYS:HE2	2.01	0.41
2:D:674:ALA:HB2	2:D:685:TYR:CE1	2.56	0.41
3:C:544:HEM:CMC	3:C:544:HEM:HBC2	2.50	0.41
1:A:26:GLY:HA3	1:A:65:MET:HG2	2.03	0.40
1:A:46:HIS:H	1:A:46:HIS:CD2	2.40	0.40
2:B:237:TRP:HA	1:C:494:ARG:HD2	2.03	0.40

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	142/144 (99%)	140 (99%)	2 (1%)	0	100	100
1	C	142/144 (99%)	140 (99%)	2 (1%)	0	100	100
2	B	144/146 (99%)	143 (99%)	1 (1%)	0	100	100
2	D	144/146 (99%)	141 (98%)	3 (2%)	0	100	100
All	All	572/580 (99%)	564 (99%)	8 (1%)	0	100	100

There are no Ramachandran outliers to report.

5.3.2 Protein sidechains ⓘ

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	117/117 (100%)	113 (97%)	4 (3%)	37	13
1	C	117/117 (100%)	113 (97%)	4 (3%)	37	13
2	B	119/119 (100%)	115 (97%)	4 (3%)	37	13
2	D	119/119 (100%)	114 (96%)	5 (4%)	30	9
All	All	472/472 (100%)	455 (96%)	17 (4%)	35	12

All (17) residues with a non-rotameric sidechain are listed below:

Mol	Chain	Res	Type
1	A	20	LYS
1	A	46	HIS
1	A	113	LYS
1	A	141	ARG
2	B	268	LEU
2	B	277	ASN
2	B	286	SER
2	B	306	LEU
1	C	409	SER
1	C	492	LYS
1	C	494	ARG
1	C	501	LYS
2	D	601	VAL

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Mol	Chain	Res	Type
2	D	659	LYS
2	D	668	LEU
2	D	695	LYS
2	D	706	LEU

Some sidechains can be flipped to improve hydrogen bonding and reduce clashes. All (7) such sidechains are listed below:

Mol	Chain	Res	Type
1	A	46	HIS
1	A	60	HIS
2	B	206	GLN
2	B	327	GLN
2	D	663	HIS
2	D	717	ASN
2	D	727	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
3	HEM	A	144	1	27,50,50	2.16	7 (25%)	17,82,82	1.98	2 (11%)
3	HEM	D	747	2	27,50,50	2.18	8 (29%)	17,82,82	2.34	9 (52%)
3	HEM	C	544	1	27,50,50	2.27	10 (37%)	17,82,82	1.59	4 (23%)
3	HEM	B	347	2	27,50,50	2.07	7 (25%)	17,82,82	1.50	2 (11%)

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	144	1	-	0/6/54/54	-
3	HEM	D	747	2	-	0/6/54/54	-
3	HEM	C	544	1	-	0/6/54/54	-
3	HEM	B	347	2	-	0/6/54/54	-

All (32) bond length outliers are listed below:

Mol	Chain	Res	Type	Atoms	Z	Observed(Å)	Ideal(Å)
3	A	144	HEM	C3D-C2D	5.34	1.53	1.37
3	D	747	HEM	C3D-C2D	5.25	1.53	1.37
3	B	347	HEM	C3D-C2D	4.94	1.52	1.37
3	D	747	HEM	C3B-C2B	-4.84	1.33	1.40
3	C	544	HEM	C3D-C2D	4.83	1.52	1.37
3	C	544	HEM	C3B-C2B	-4.66	1.33	1.40
3	B	347	HEM	C3C-C2C	-4.61	1.34	1.40
3	D	747	HEM	C3C-C2C	-4.29	1.34	1.40
3	A	144	HEM	C3B-C2B	-4.27	1.34	1.40
3	A	144	HEM	C3C-C2C	-4.23	1.34	1.40
3	C	544	HEM	C3C-C2C	-3.97	1.34	1.40
3	C	544	HEM	C3B-CAB	3.77	1.55	1.47
3	A	144	HEM	C3C-CAC	3.65	1.55	1.47
3	B	347	HEM	C3B-C2B	-3.50	1.35	1.40
3	B	347	HEM	C3C-CAC	3.43	1.54	1.47
3	C	544	HEM	CAA-C2A	3.34	1.56	1.52
3	C	544	HEM	C3C-CAC	3.23	1.54	1.47
3	D	747	HEM	C3C-CAC	3.16	1.54	1.47
3	D	747	HEM	CAA-C2A	3.11	1.56	1.52
3	A	144	HEM	C3B-CAB	2.75	1.53	1.47
3	A	144	HEM	CAA-C2A	2.71	1.56	1.52
3	D	747	HEM	C3B-CAB	2.68	1.53	1.47

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Mol	Chain	Res	Type	Atoms	Z	Observed(Å)	Ideal(Å)
3	B	347	HEM	C3B-CAB	2.66	1.53	1.47
3	B	347	HEM	CMB-C2B	2.34	1.57	1.51
3	C	544	HEM	CMA-C3A	2.29	1.56	1.51
3	D	747	HEM	CMA-C3A	2.22	1.56	1.51
3	D	747	HEM	CMC-C2C	2.20	1.56	1.51
3	C	544	HEM	CMB-C2B	2.16	1.56	1.51
3	B	347	HEM	CAA-C2A	2.14	1.55	1.52
3	A	144	HEM	CMA-C3A	2.09	1.56	1.51
3	C	544	HEM	C4B-NB	2.02	1.40	1.36
3	C	544	HEM	CMD-C2D	2.00	1.55	1.51

All (17) bond angle outliers are listed below:

Mol	Chain	Res	Type	Atoms	Z	Observed(°)	Ideal(°)
3	A	144	HEM	CBD-CAD-C3D	-5.76	101.87	112.48
3	D	747	HEM	CAD-CBD-CGD	-5.39	103.63	112.67
3	A	144	HEM	C1D-C2D-C3D	-4.35	103.97	107.00
3	B	347	HEM	CBA-CAA-C2A	-3.95	105.19	112.49
3	D	747	HEM	CAA-CBA-CGA	3.39	118.36	112.67
3	C	544	HEM	C1D-C2D-C3D	-3.28	104.72	107.00
3	D	747	HEM	CBD-CAD-C3D	3.15	118.29	112.48
3	C	544	HEM	CMA-C3A-C4A	-3.15	123.63	128.46
3	D	747	HEM	C4C-C3C-C2C	2.89	108.92	106.90
3	C	544	HEM	CMA-C3A-C2A	2.60	129.84	124.94
3	C	544	HEM	CBD-CAD-C3D	2.50	117.09	112.48
3	D	747	HEM	CBA-CAA-C2A	-2.32	108.20	112.49
3	D	747	HEM	CMC-C2C-C3C	2.21	128.81	124.68
3	D	747	HEM	CMB-C2B-C3B	2.20	128.78	124.68
3	B	347	HEM	CMB-C2B-C3B	2.16	128.73	124.68
3	D	747	HEM	C1D-C2D-C3D	-2.07	105.56	107.00
3	D	747	HEM	C3B-C4B-NB	-2.02	106.60	109.21

There are no chirality outliers.

There are no torsion outliers.

There are no ring outliers.

4 monomers are involved in 8 short contacts:

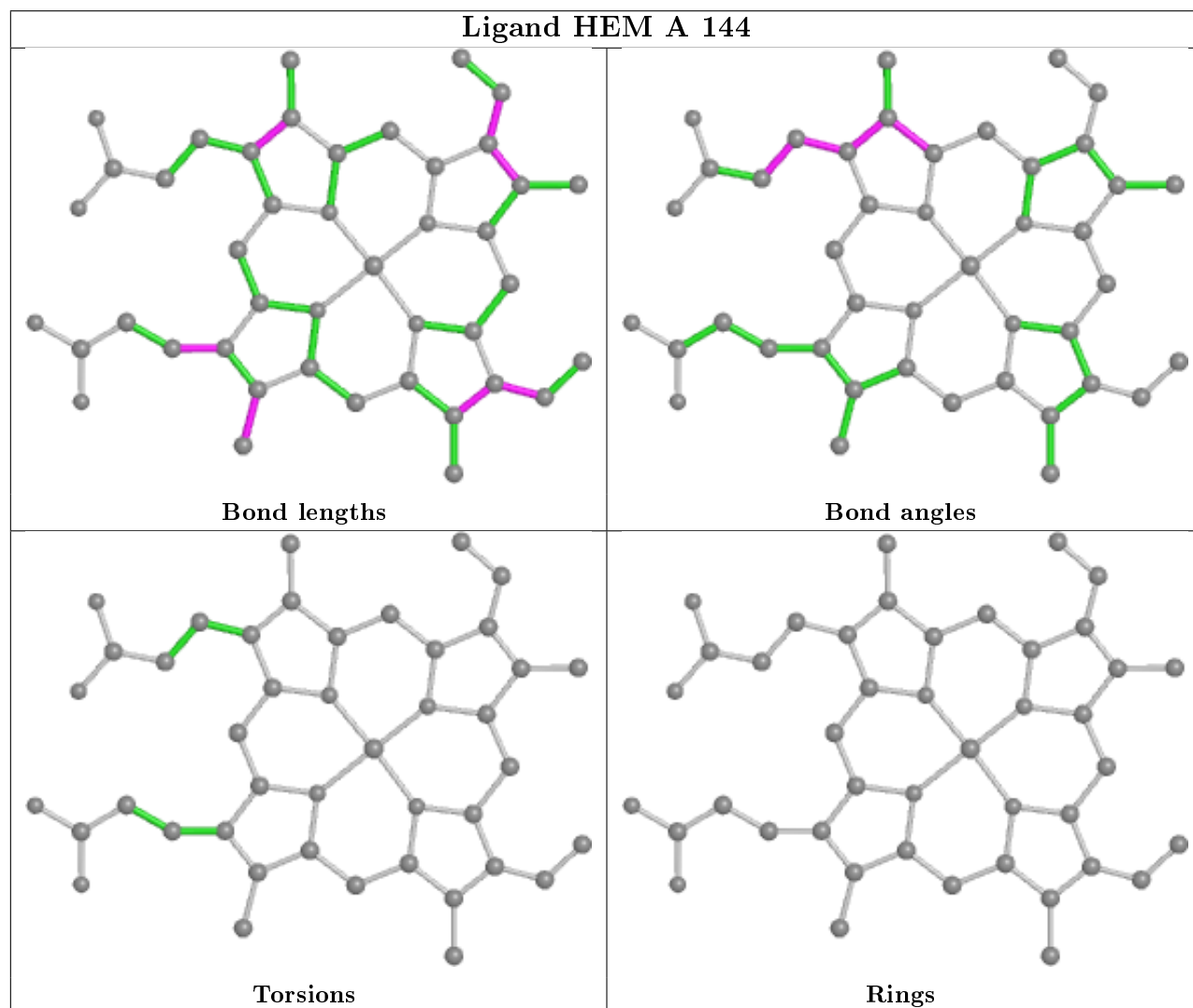
Mol	Chain	Res	Type	Clashes	Symm-Clashes
3	A	144	HEM	4	0
3	D	747	HEM	1	0
3	C	544	HEM	2	0

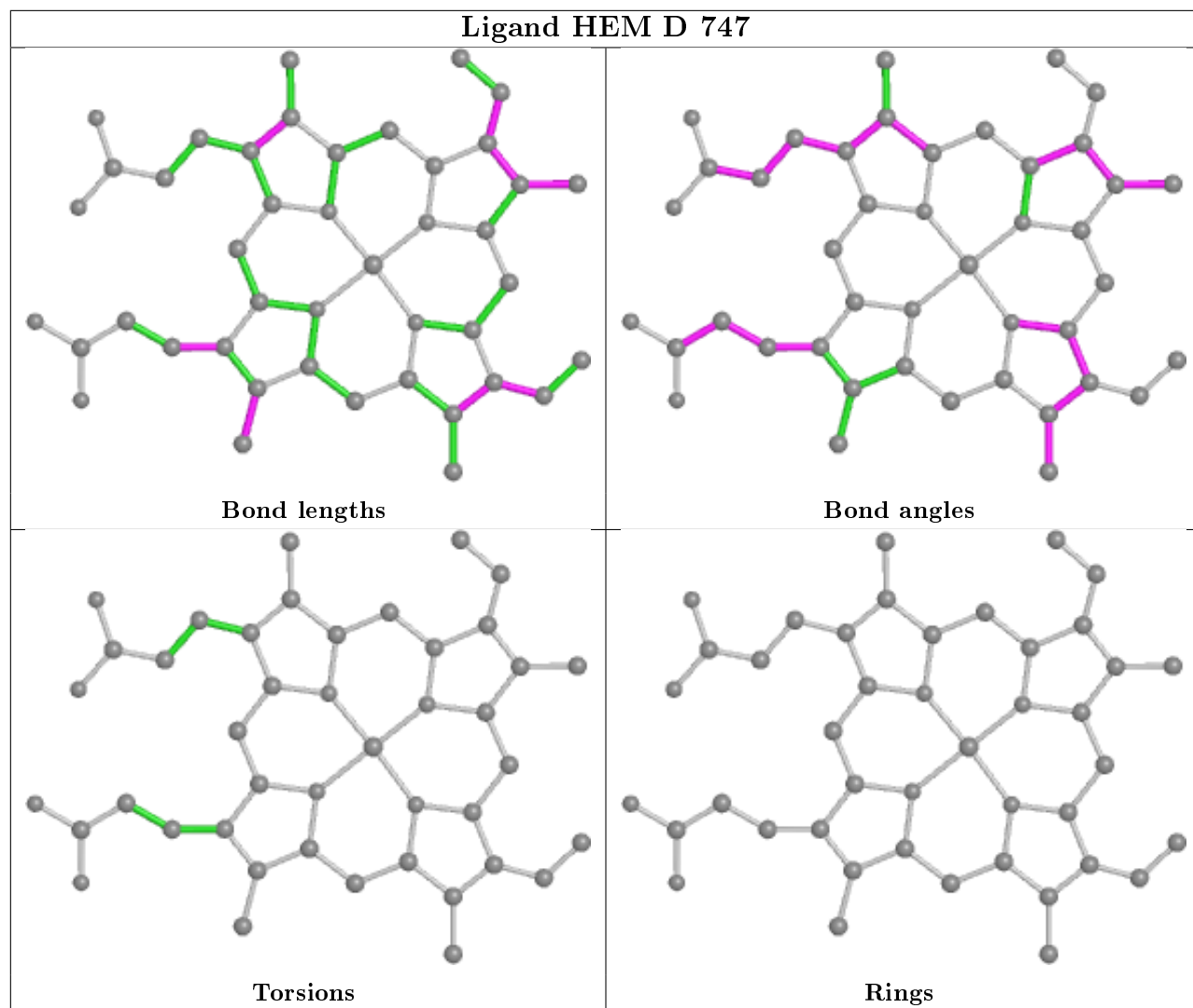
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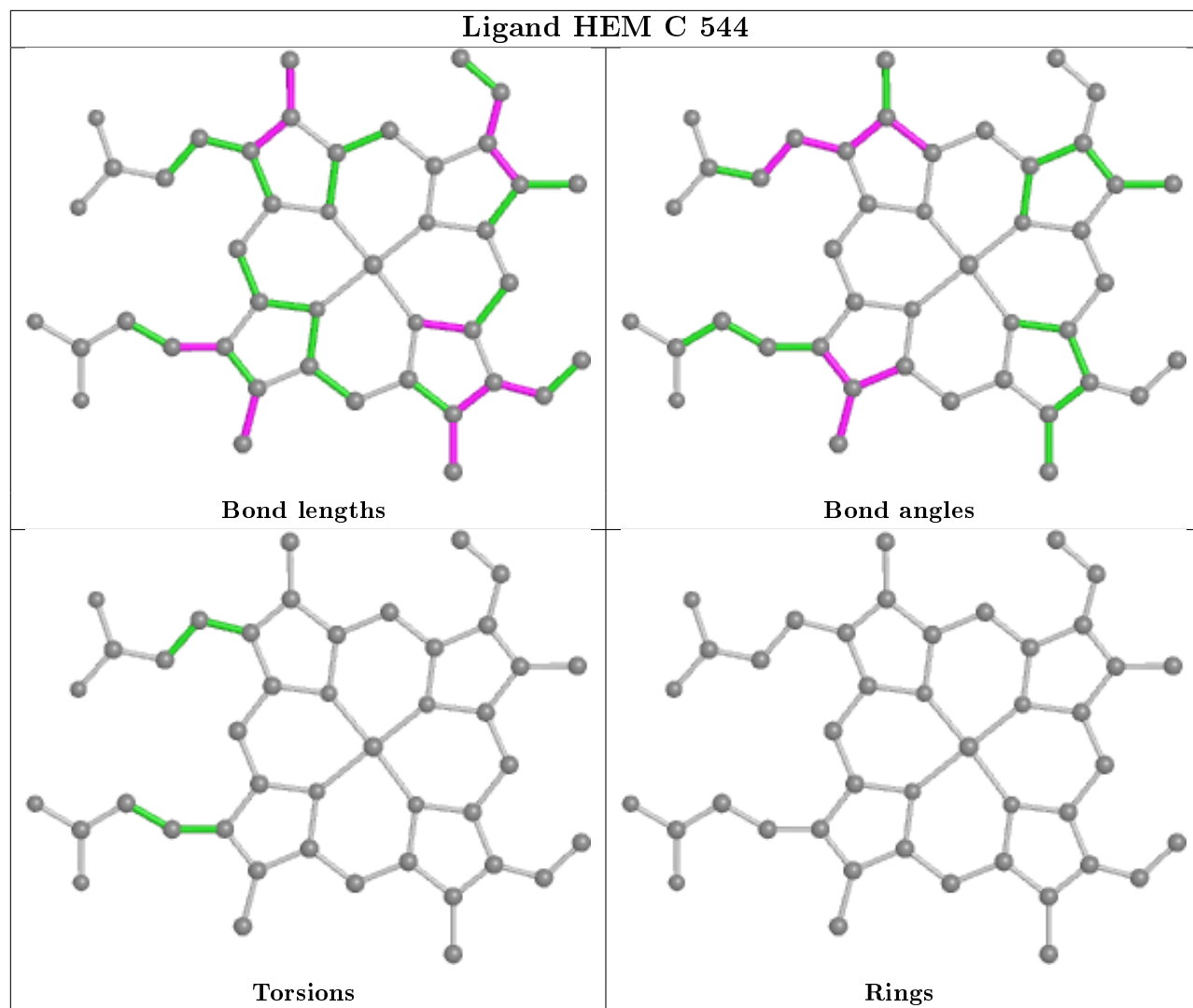
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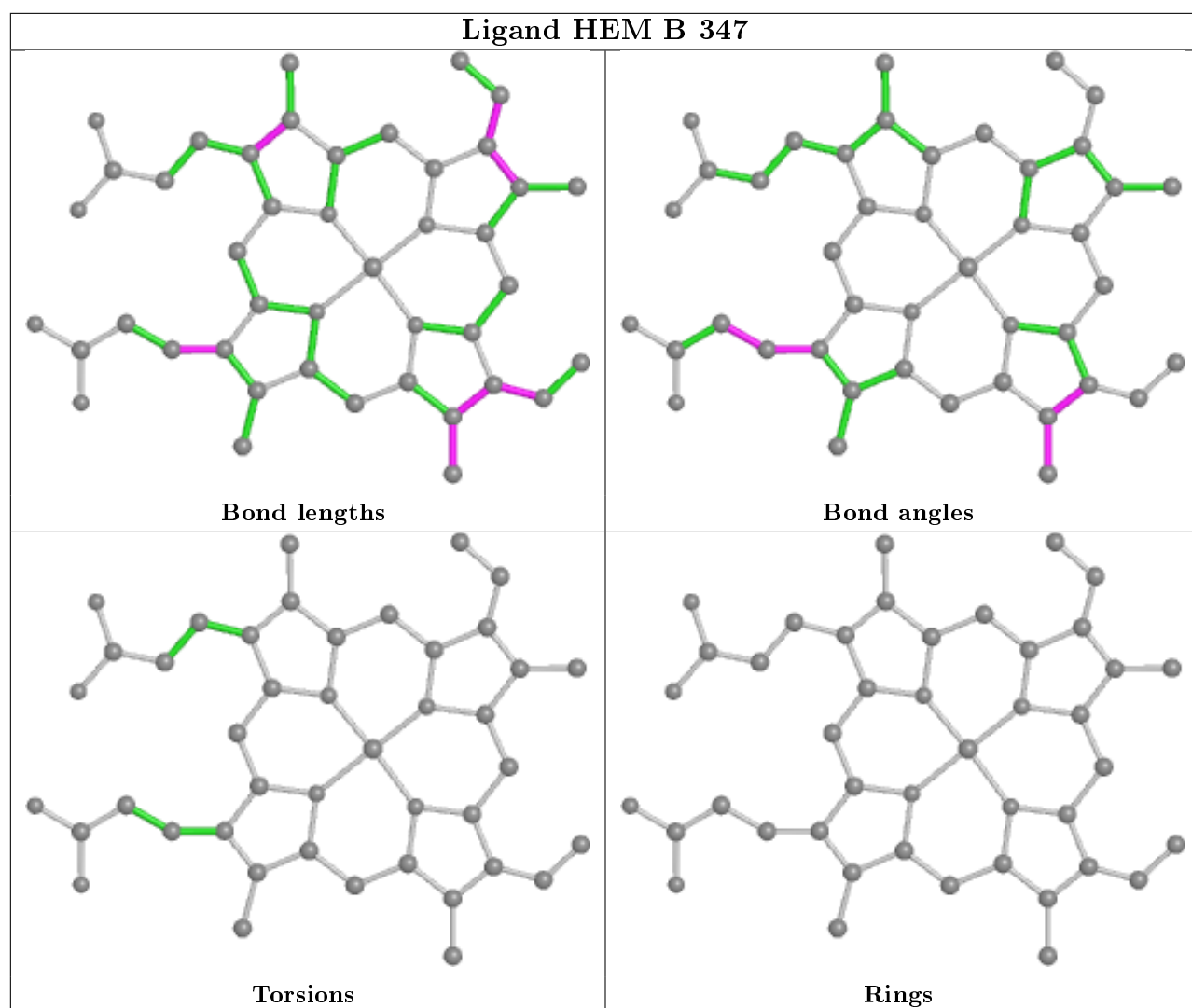
Mol	Chain	Res	Type	Clashes	Symm-Clashes
3	B	347	HEM	1	0

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.