WORLDWIDE PDB
PROTEIN DATA BANK

Full wwPDB NMR Structure Validation Report ⓘ

May 28, 2020 – 11:06 pm BST

PDB ID	:	2L4D
Title	:	cytochrome c domain of pp3183 protein from Pseudomonas putida
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Deposited on	:	2010-10-04

This is a Full wwPDB NMR 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/NMRValidationReportHelp
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:

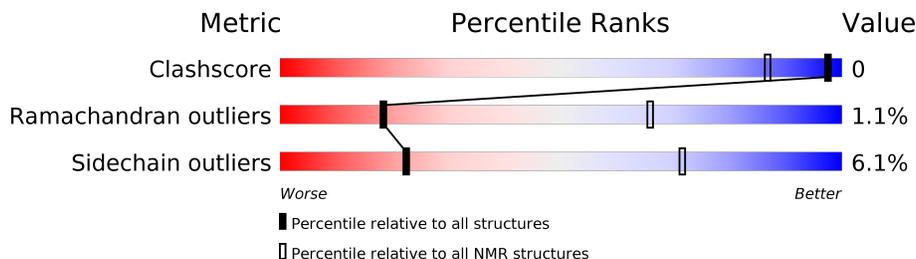|		
Cyrange	:	Kirchner and Güntert (2011)
NmrClust	:	Kelley et al. (1996)
MolProbity	:	4.02b-467
Mogul	:	1.8.5 (274361), CSD as541be (2020)
buster-report	:	1.1.7 (2018)
Percentile statistics	:	20191225.v01 (using entries in the PDB archive December 25th 2019)
RCI	:	v_1n_11_5_13_A (Berjanski et al., 2005)
PANAV	:	Wang et al. (2010)
ShiftChecker	:	2.11
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:
SOLUTION NMR

The overall completeness of chemical shifts assignment was not calculated.

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	Percentile Ranks	Value
Clashscore		0
Ramachandran outliers		1.1%
Sidechain outliers		6.1%

Worse   *Better*

▮ Percentile relative to all structures
▯ Percentile relative to all NMR structures

Metric	Whole archive (#Entries)	NMR archive (#Entries)
Clashscore	158937	12864
Ramachandran outliers	154571	11451
Sidechain outliers	154315	11428

The table below summarises the geometric issues observed across the polymeric chains and their fit to the experimental data. The red, orange, yellow and green segments indicate the fraction of residues that contain outliers for >=3, 2, 1 and 0 types of geometric quality criteria. A cyan segment indicates the fraction of residues that are not part of the well-defined cores, and 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%

Mol	Chain	Length	Quality of chain
1	A	110	75% • 21% •

2 Ensemble composition and analysis (i)

This entry contains 20 models. Model 8 is the overall representative, medoid model (most similar to other models). The authors have identified model 1 as representative, based on the following criterion: *lowest energy.*

The following residues are included in the computation of the global validation metrics.

Well-defined (core) protein residues			
Well-defined core	Residue range (total)	Backbone RMSD (Å)	Medoid model
1	A:2-A:17, A:28-A:94 (83)	0.55	8

Ill-defined regions of proteins are excluded from the global statistics.

Ligands and non-protein polymers are included in the analysis.

The models can be grouped into 2 clusters and 2 single-model clusters were found.

Cluster number	Models
1	1, 2, 3, 4, 6, 7, 8, 9, 10, 12, 13, 14, 15, 16, 18, 20
2	11, 19
Single-model clusters	5; 17

3 Entry composition (i)

There are 2 unique types of molecules in this entry. The entry contains 1733 atoms, of which 858 are hydrogens and 0 are deuteriums.

- Molecule 1 is a protein called SCO1/SenC family protein/cytochrome c.

Mol	Chain	Residues	Atoms						Trace
			Total	C	H	N	O	S	
1	A	106	1658	518	826	150	158	6	0

There are 4 discrepancies between the modelled and reference sequences:

Chain	Residue	Modelled	Actual	Comment	Reference
A	-3	GLY	-	EXPRESSION TAG	UNP Q88I19
A	-2	SER	-	EXPRESSION TAG	UNP Q88I19
A	-1	PHE	-	EXPRESSION TAG	UNP Q88I19
A	0	THR	-	EXPRESSION TAG	UNP Q88I19

- Molecule 2 is HEME C (three-letter code: HEC) (formula: $C_{34}H_{34}FeN_4O_4$).
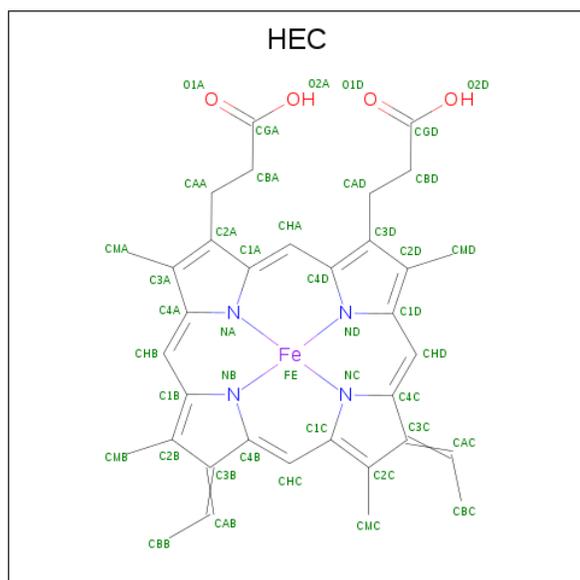
Mol	Chain	Residues	Atoms					
			Total	C	Fe	H	N	O
2	A	1	75	34	1	32	4	4

4 Residue-property plots (i)

4.1 Average score per residue in the NMR ensemble

These plots are provided for all protein, RNA and DNA chains in the entry. The first graphic is the same as shown in the summary in section 1 of this report. The second graphic shows the sequence where residues are colour-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 outliers are shown as green connectors. Residues which are classified as ill-defined in the NMR ensemble, are shown in cyan with an underline colour-coded according to the previous scheme. Residues which were present in the experimental sample, but not modelled in the final structure are shown in grey.

• Molecule 1: SCO1/SenC family protein/cytochrome c

Chain A:
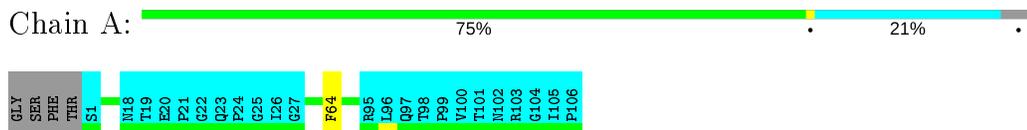
4.2 Scores per residue for each member of the ensemble

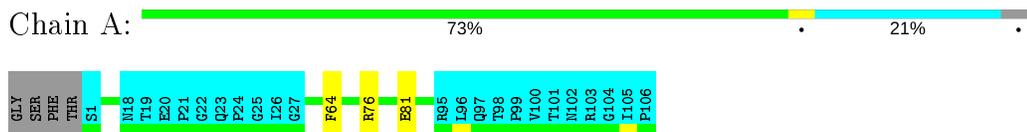Colouring as in section 4.1 above.

4.2.1 Score per residue for model 1
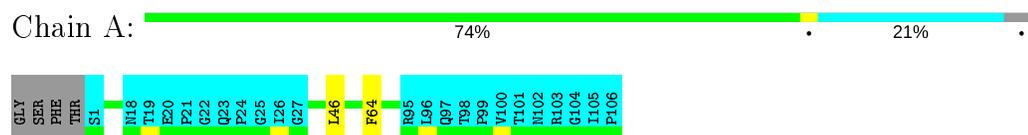
• Molecule 1: SCO1/SenC family protein/cytochrome c

Chain A:

4.2.2 Score per residue for model 2

• Molecule 1: SCO1/SenC family protein/cytochrome c
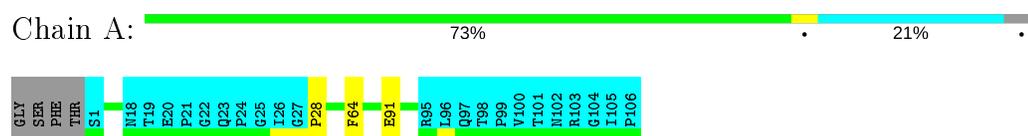
Chain A:

4.2.3 Score per residue for model 3

● Molecule 1: SCO1/SenC family protein/cytochrome c

Chain A:

4.2.4 Score per residue for model 4

● Molecule 1: SCO1/SenC family protein/cytochrome c

Chain A:

4.2.5 Score per residue for model 5

● Molecule 1: SCO1/SenC family protein/cytochrome c

Chain A:

4.2.6 Score per residue for model 6

● Molecule 1: SCO1/SenC family protein/cytochrome c

Chain A:

4.2.7 Score per residue for model 7

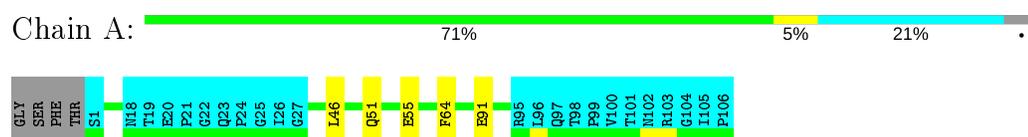● Molecule 1: SCO1/SenC family protein/cytochrome c

Chain A:

4.2.8 Score per residue for model 8 (medoid)

• Molecule 1: SCO1/SenC family protein/cytochrome c

Chain A:

4.2.9 Score per residue for model 9

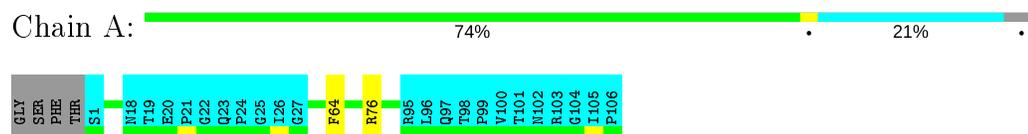• Molecule 1: SCO1/SenC family protein/cytochrome c

Chain A:

4.2.10 Score per residue for model 10

• Molecule 1: SCO1/SenC family protein/cytochrome c

Chain A:

4.2.11 Score per residue for model 11

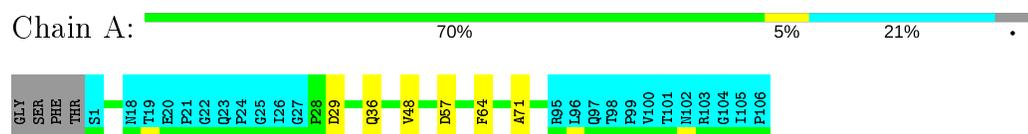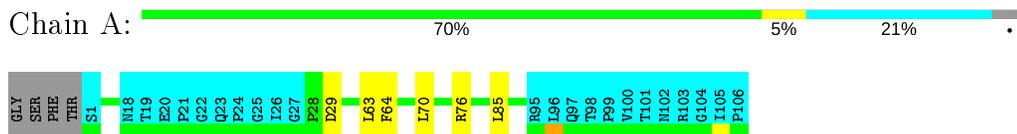• Molecule 1: SCO1/SenC family protein/cytochrome c

Chain A:

4.2.12 Score per residue for model 12

• Molecule 1: SCO1/SenC family protein/cytochrome c

Chain A:

4.2.13 Score per residue for model 13

• Molecule 1: SCO1/SenC family protein/cytochrome c

Chain A:

4.2.14 Score per residue for model 14

• Molecule 1: SCO1/SenC family protein/cytochrome c

Chain A:

4.2.15 Score per residue for model 15

• Molecule 1: SCO1/SenC family protein/cytochrome c

Chain A:

4.2.16 Score per residue for model 16

• Molecule 1: SCO1/SenC family protein/cytochrome c

Chain A:

4.2.17 Score per residue for model 17

• Molecule 1: SCO1/SenC family protein/cytochrome c

Chain A:
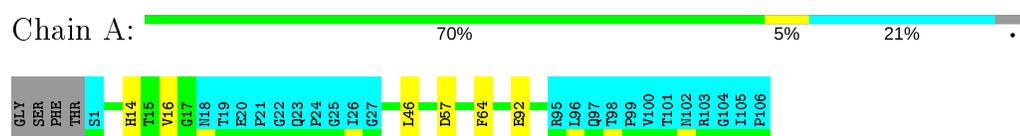
4.2.18 Score per residue for model 18

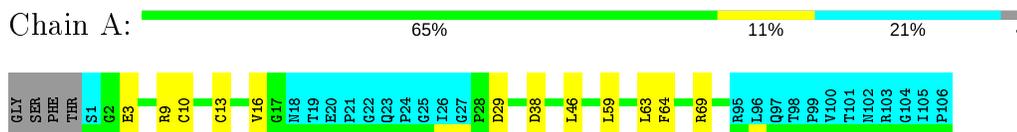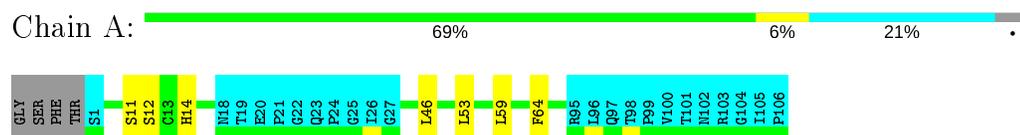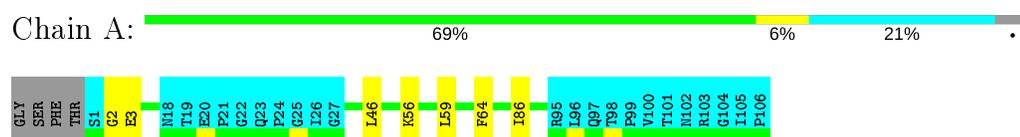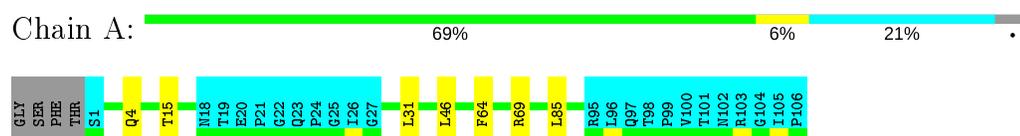• Molecule 1: SCO1/SenC family protein/cytochrome c

Chain A:

69%   6%   21%

GLY SER PHE THR S1 G2 E3 H14 N18 T19 E20 P21 G22 Q23 P24 G25 I26 G27 P28 L46 K56 L63 F64 R95 L96 Q97 T98 P99 V100 T101 N102 R103 G104 I105 P106
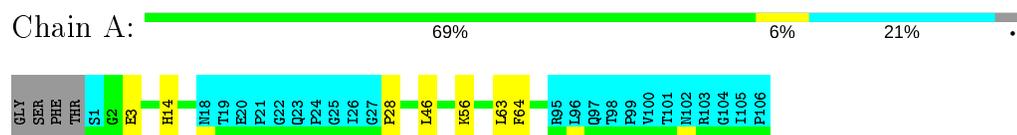
4.2.19 Score per residue for model 19

• Molecule 1: SCO1/SenC family protein/cytochrome c

Chain A:

66%   9%   21%

GLY SER PHE THR S1 C10 V16 G17 N18 T19 E20 P21 G22 Q23 P24 G25 I26 G27 P28 G32 V33 T34 R35 R44 E55 F64 M75 R95 L96 Q97 T98 P99 V100 T101 N102 R103 G104 I105 P106
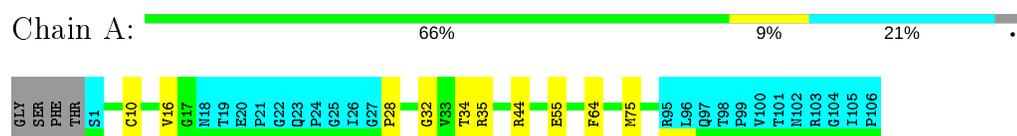
4.2.20 Score per residue for model 20

• Molecule 1: SCO1/SenC family protein/cytochrome c

Chain A:

67%   7%   21%

GLY SER PHE THR S1 H14 N18 T19 E20 P21 G22 Q23 P24 G25 I26 G27 I31 L46 D57 P58 L59 L63 F64 E65 M75 R95 L96 Q97 T98 P99 V100 T101 N102 R103 G104 I105 P106
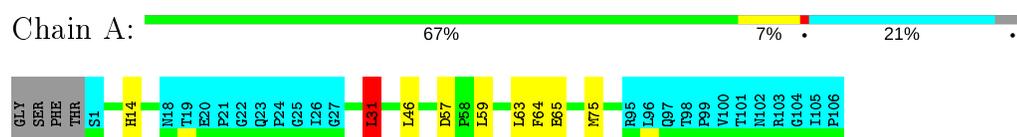
5 Refinement protocol and experimental data overview (i)

The models were refined using the following method: *molecular dynamics*.

Of the 20 calculated structures, 20 were deposited, based on the following criterion: *structures with the lowest energy*.

The following table shows the software used for structure solution, optimisation and refinement.

Software name	Classification	Version
CYANA	structure solution	
AMBER	refinement	

No chemical shift data was provided. No validations of the models with respect to experimental NMR restraints is performed at this time.

COVALENT-GEOMETRY INFOmissingINFO

5.1 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 each 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 averaged over the ensemble.

Mol	Chain	Non-H	H(model)	H(added)	Clashes
1	A	664	658	658	0±0
2	A	43	32	30	1±1
All	All	14140	13800	13760	13

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 0.

All unique clashes are listed below, sorted by their clash magnitude.

Atom-1	Atom-2	Clash(Å)	Distance(Å)	Models	
				Worst	Total
2:A:107:HEC:HBC3	2:A:107:HEC:HMC1	0.68	1.65	20	3
2:A:107:HEC:HMC1	2:A:107:HEC:HBC3	0.60	1.70	16	2
2:A:107:HEC:HMB1	2:A:107:HEC:HBB3	0.56	1.76	11	1
2:A:107:HEC:CHA	2:A:107:HEC:CGD	0.44	2.95	1	1
1:A:85:LEU:HD21	2:A:107:HEC:HMB1	0.44	1.89	12	2
2:A:107:HEC:CBB	2:A:107:HEC:HMB1	0.43	2.44	11	1
2:A:107:HEC:HBB3	2:A:107:HEC:HMB1	0.41	1.92	16	1
1:A:31:LEU:HD22	1:A:31:LEU:C	0.41	2.36	20	1
1:A:10:CYS:SG	2:A:107:HEC:HMB1	0.41	2.56	19	1

5.2 Torsion angles (i)

5.2.1 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 PDB entries followed by that with respect to all NMR entries. 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	83/110 (75%)	75±2 (91±2%)	7±2 (8±2%)	1±1 (1±1%)	18	66
All	All	1660/2200 (75%)	1507 (91%)	135 (8%)	18 (1%)	18	66

All 12 unique Ramachandran outliers are listed below. They are sorted by the frequency of occurrence in the ensemble.

Mol	Chain	Res	Type	Models (Total)
1	A	56	LYS	3
1	A	75	MET	3
1	A	59	LEU	2
1	A	28	PRO	2
1	A	71	ALA	1
1	A	32	GLY	1
1	A	2	GLY	1
1	A	55	GLU	1
1	A	76	ARG	1
1	A	57	ASP	1
1	A	12	SER	1
1	A	38	ASP	1

5.2.2 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 PDB entries followed by that with respect to all NMR entries. 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	72/94 (77%)	68±2 (94±3%)	4±2 (6±3%)	22	71
All	All	1440/1880 (77%)	1352 (94%)	88 (6%)	22	71

All 34 unique residues with a non-rotameric sidechain are listed below. They are sorted by the frequency of occurrence in the ensemble.

Mol	Chain	Res	Type	Models (Total)
1	A	64	PHE	20
1	A	46	LEU	10
1	A	14	HIS	6
1	A	59	LEU	4
1	A	63	LEU	4
1	A	29	ASP	4
1	A	3	GLU	3
1	A	16	VAL	3
1	A	91	GLU	2
1	A	55	GLU	2
1	A	76	ARG	2
1	A	31	LEU	2
1	A	85	LEU	2
1	A	86	ILE	2
1	A	69	ARG	2
1	A	81	GLU	2
1	A	87	SER	1
1	A	10	CYS	1
1	A	53	LEU	1
1	A	70	LEU	1
1	A	15	THR	1
1	A	35	ARG	1
1	A	36	GLN	1
1	A	51	GLN	1
1	A	34	THR	1
1	A	65	GLU	1
1	A	44	ARG	1
1	A	57	ASP	1
1	A	13	CYS	1
1	A	92	GLU	1
1	A	11	SER	1
1	A	48	VAL	1
1	A	4	GLN	1
1	A	9	ARG	1

5.2.3   RNA (i)

There are no RNA molecules in this entry.

5.3   Non-standard residues in protein, DNA, RNA chains (i)

There are no non-standard protein/DNA/RNA residues in this entry.

5.4 Carbohydrates (i)

There are no carbohydrates in this entry.

5.5 Ligand geometry (i)

1 ligand is modelled in this entry.

In the following table, the Counts columns list the number of bonds for which Mogul statistics could be retrieved, the number of bonds that are observed in the model and the number of bonds 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 is the number of standard deviations the observed value is removed from the expected value. A bond length with $|Z| > 2$ is considered an outlier worth inspection. RMSZ is the average root-mean-square of all Z scores of the bond lengths.

Mol	Type	Chain	Res	Link	Bond lengths		
					Counts	RMSZ	#Z>2
2	HEC	A	107	1	26,50,50	0.83±0.02	0±0 (0±0%)

In the following table, the Counts columns list the number of angles for which Mogul statistics could be retrieved, the number of angles that are observed in the model and the number of 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 angle is the number of standard deviations the observed value is removed from the expected value. A bond angle with $|Z| > 2$ is considered an outlier worth inspection. RMSZ is the average root-mean-square of all Z scores of the bond angles.

Mol	Type	Chain	Res	Link	Bond angles		
					Counts	RMSZ	#Z>2
2	HEC	A	107	1	18,82,82	1.13±0.10	0±0 (0±0%)

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	HEC	A	107	1	-	0±0,6,54,54	-

There are no bond-length outliers.

There are no bond-angle outliers.

There are no chirality outliers.

There are no torsion outliers.

There are no ring outliers.

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 HEC A 107

Bond lengths

Bond angles

Torsions

Rings
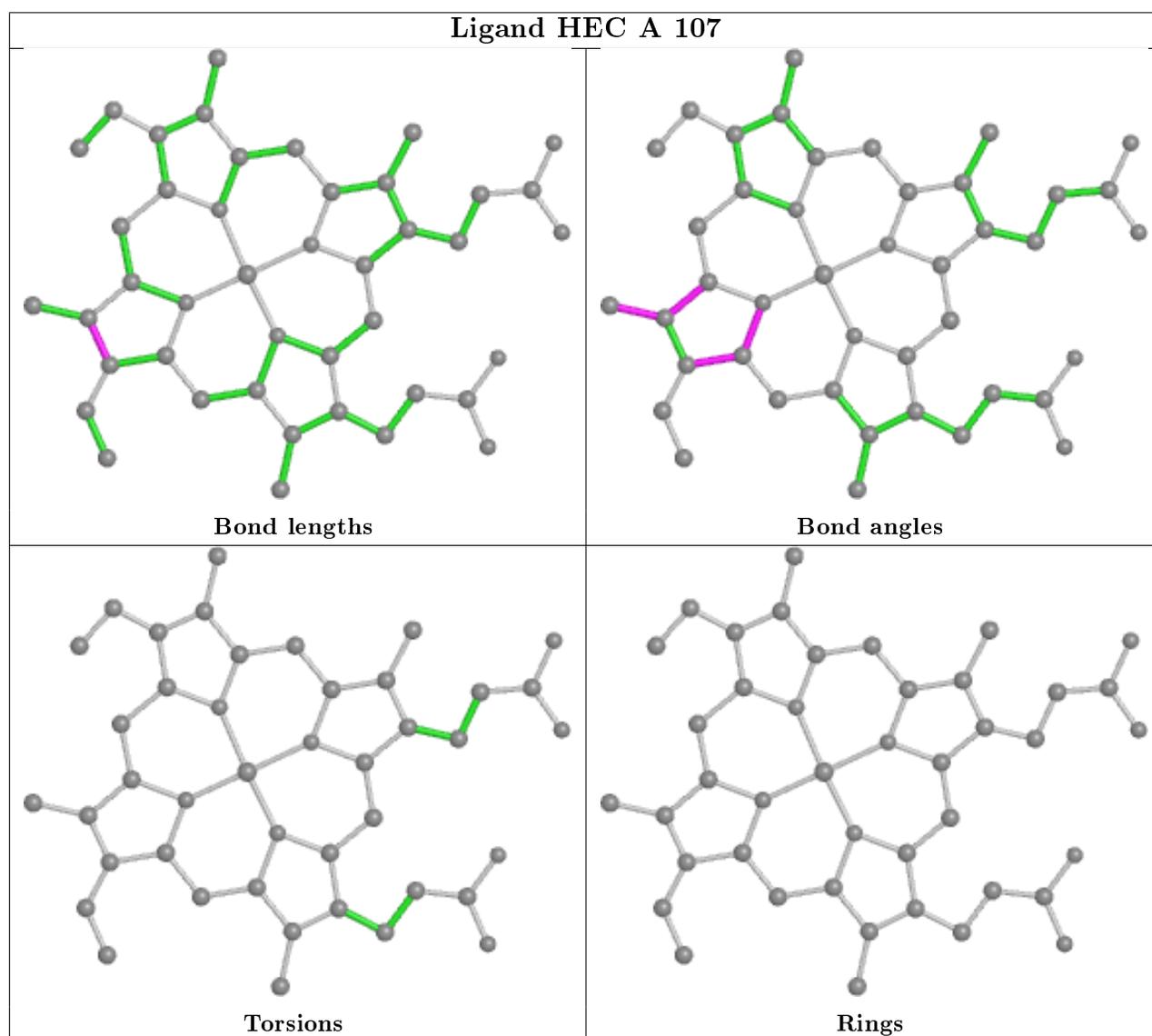
5.6 Other polymers (i)

There are no such molecules in this entry.

5.7 Polymer linkage issues (i)

There are no chain breaks in this entry.

6 Chemical shift validation (i)

No chemical shift data were provided