



# wwPDB X-ray Structure Validation Summary Report ⓘ

Mar 1, 2026 – 02:02 AM UTC

PDB ID : 5VBU / pdb\_00005vbu  
Title : Crystal Structure of Human Cytochrome P450 21A2 Hydroxyprogesterone Complex  
Authors : Pallan, P.S.; Egli, M.  
Deposited on : 2017-03-30  
Resolution : 3.31 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](mailto: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>.

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

MolProbity : 4-5-2 with Phenix2.0  
Mogul : 2022.3.0, CSD as543be (2022)  
Xtrriage (Phenix) : 2.0  
EDS : 3.0  
Buster-report : wwPDB partial adaption of 1.1.7 (2018)  
Percentile statistics : 20250101.v01 (using entries in the PDB archive January 1st 2025)  
CCP4 : 9.0.010 (Gargrove)  
Density-Fitness : 1.0.12  
Ideal geometry (proteins) : Engh & Huber (2001)  
Ideal geometry (DNA, RNA) : Parkinson et al. (1996)  
Validation Pipeline (wwPDB-VP) : 2.49

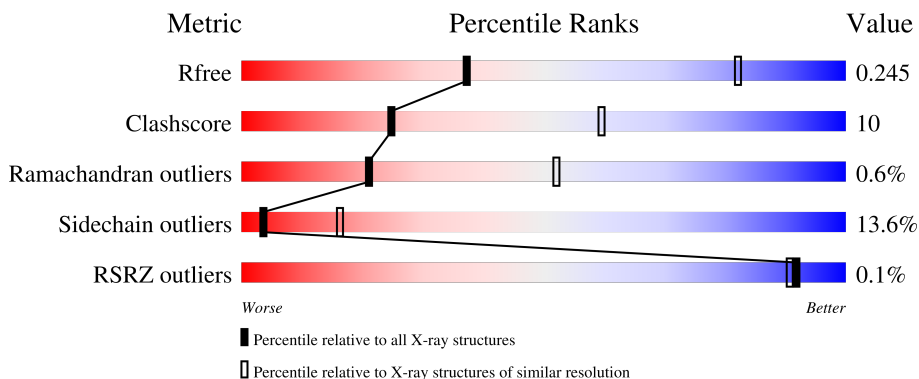
# 1 Overall quality at a glance

The following experimental techniques were used to determine the structure:

*X-RAY DIFFRACTION*

The reported resolution of this entry is 3.31 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))
$R_{free}$	180053	1153 (3.34-3.30)
Clashscore	190562	1193 (3.34-3.30)
Ramachandran outliers	187476	1172 (3.34-3.30)
Sidechain outliers	187428	1171 (3.34-3.30)
RSRZ outliers	180081	1153 (3.34-3.30)

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  $\geq 3$ , 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  $\leq 5\%$ . 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	A	476	67% 21% 5% 7%
1	B	476	68% 21% 5% 7%
1	C	476	66% 23% 5% 7%

## 2 Entry composition [i](#)

There are 4 unique types of molecules in this entry. The entry contains 10795 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 Cytochrome P450 21-hydroxylase.

Mol	Chain	Residues	Atoms					ZeroOcc	AltConf	Trace
			Total	C	N	O	S			
1	A	442	3531	2279	617	618	17	159	0	0
1	B	441	3527	2277	616	617	17	116	0	0
1	C	442	3531	2279	617	618	17	82	0	0

There are 30 discrepancies between the modelled and reference sequences:

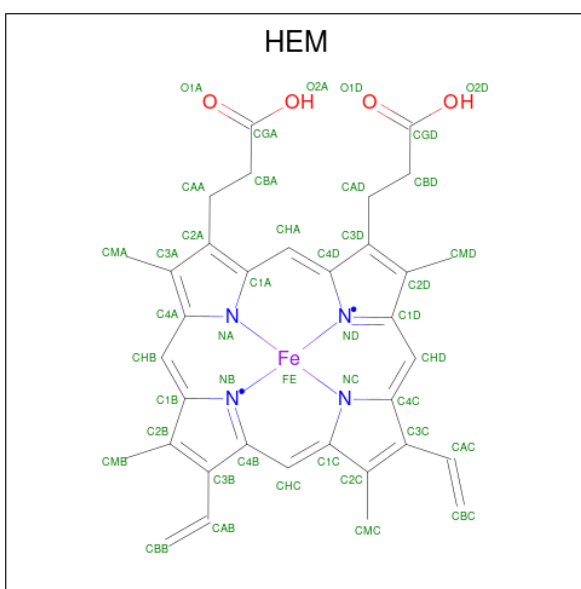
Chain	Residue	Modelled	Actual	Comment	Reference
A	20	MET	-	initiating methionine	UNP Q16874
A	21	ALA	-	expression tag	UNP Q16874
A	22	LYS	-	expression tag	UNP Q16874
A	23	LYS	-	expression tag	UNP Q16874
A	24	THR	-	expression tag	UNP Q16874
A	25	SER	-	expression tag	UNP Q16874
A	26	SER	-	expression tag	UNP Q16874
A	27	LYS	-	expression tag	UNP Q16874
A	28	GLY	-	expression tag	UNP Q16874
A	29	LYS	-	expression tag	UNP Q16874
B	20	MET	-	initiating methionine	UNP Q16874
B	21	ALA	-	expression tag	UNP Q16874
B	22	LYS	-	expression tag	UNP Q16874
B	23	LYS	-	expression tag	UNP Q16874
B	24	THR	-	expression tag	UNP Q16874
B	25	SER	-	expression tag	UNP Q16874
B	26	SER	-	expression tag	UNP Q16874
B	27	LYS	-	expression tag	UNP Q16874
B	28	GLY	-	expression tag	UNP Q16874
B	29	LYS	-	expression tag	UNP Q16874
C	20	MET	-	initiating methionine	UNP Q16874
C	21	ALA	-	expression tag	UNP Q16874
C	22	LYS	-	expression tag	UNP Q16874

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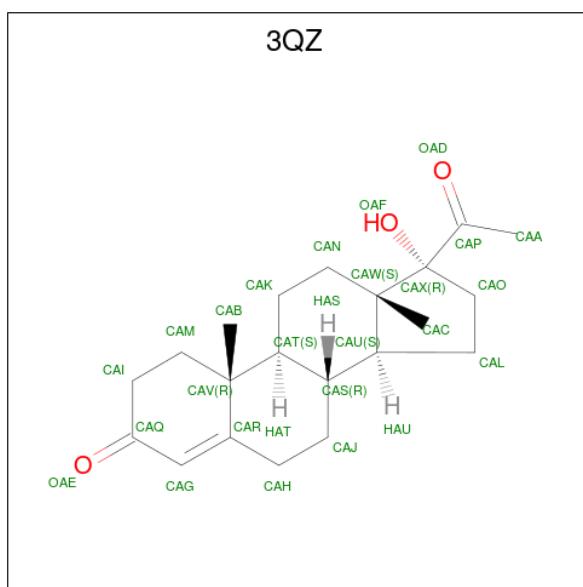
Chain	Residue	Modelled	Actual	Comment	Reference
C	23	LYS	-	expression tag	UNP Q16874
C	24	THR	-	expression tag	UNP Q16874
C	25	SER	-	expression tag	UNP Q16874
C	26	SER	-	expression tag	UNP Q16874
C	27	LYS	-	expression tag	UNP Q16874
C	28	GLY	-	expression tag	UNP Q16874
C	29	LYS	-	expression tag	UNP Q16874

- Molecule 2 is PROTOPORPHYRIN IX CONTAINING FE (CCD ID: HEM) (formula:  $C_{34}H_{32}FeN_4O_4$ ).



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

- Molecule 3 is (9beta)-17-hydroxypregn-4-ene-3,20-dione (CCD ID: 3QZ) (formula:  $C_{21}H_{30}O_3$ ).



Mol	Chain	Residues	Atoms		ZeroOcc	AltConf
3	A	1	Total	C O	0	0
			24	21 3		
3	B	1	Total	C O	0	0
			24	21 3		
3	C	1	Total	C O	0	0
			24	21 3		

- Molecule 4 is water.

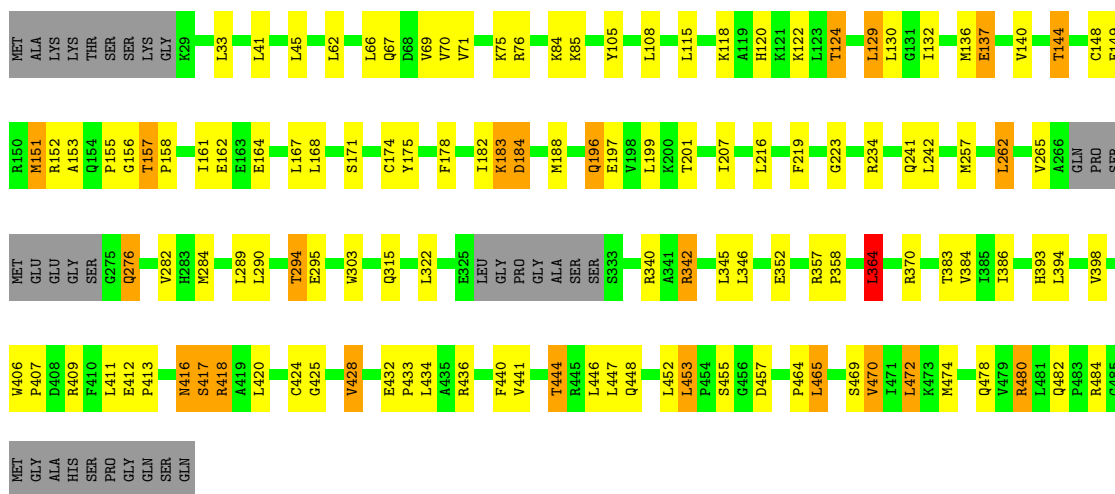
Mol	Chain	Residues	Atoms		ZeroOcc	AltConf
4	A	1	Total	O	0	0
			1	1		
4	B	4	Total	O	0	0
			4	4		

### 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 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.

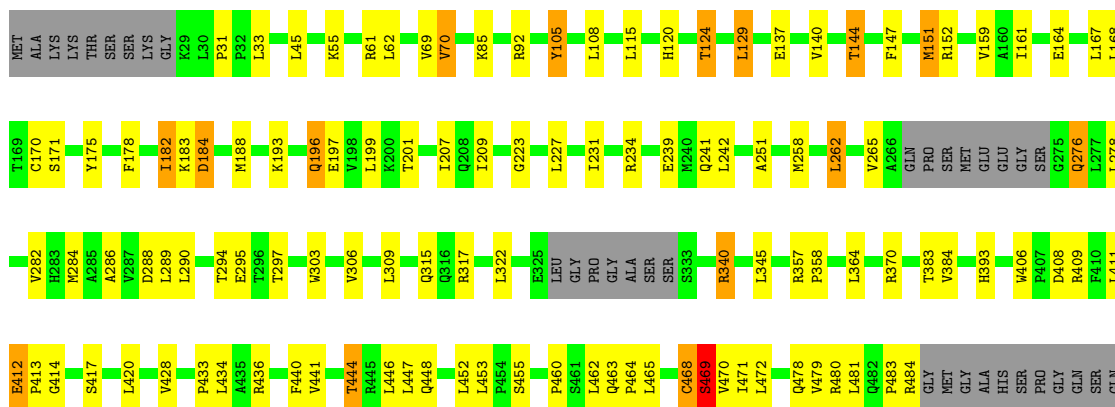
- Molecule 1: Cytochrome P450 21-hydroxylase

Chain A: 



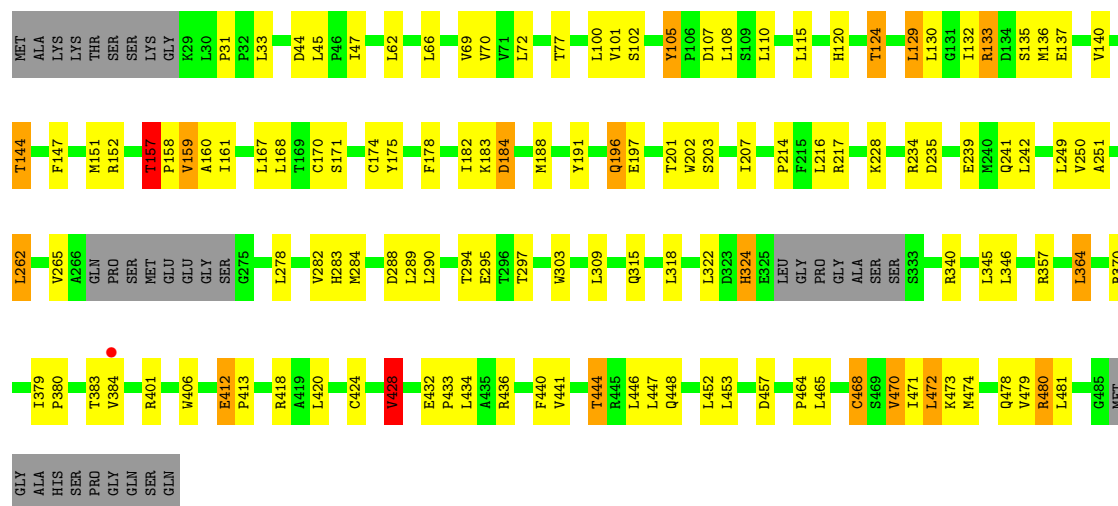
- Molecule 1: Cytochrome P450 21-hydroxylase

Chain B: 



- Molecule 1: Cytochrome P450 21-hydroxylase

Chain C: 



## 4 Data and refinement statistics

Property	Value	Source
Space group	C 1 2 1	Depositor
Cell constants a, b, c, $\alpha$ , $\beta$ , $\gamma$	152.43Å 88.39Å 111.42Å 90.00° 102.37° 90.00°	Depositor
Resolution (Å)	108.83 – 3.31 108.83 – 3.31	Depositor EDS
% Data completeness (in resolution range)	91.2 (108.83-3.31) 91.3 (108.83-3.31)	Depositor EDS
$R_{merge}$	0.11	Depositor
$R_{sym}$	(Not available)	Depositor
$\langle I/\sigma(I) \rangle$ <sup>1</sup>	1.85 (at 3.32Å)	Xtrriage
Refinement program	REFMAC 5.8.0158	Depositor
R, $R_{free}$	0.191 , 0.241 0.200 , 0.245	Depositor DCC
$R_{free}$ test set	1549 reflections (7.13%)	wwPDB-VP
Wilson B-factor (Å <sup>2</sup> )	91.2	Xtrriage
Anisotropy	0.294	Xtrriage
Bulk solvent $k_{sol}$ (e/Å <sup>3</sup> ), $B_{sol}$ (Å <sup>2</sup> )	0.34 , 78.4	EDS
L-test for twinning <sup>2</sup>	$\langle  L  \rangle = 0.48$ , $\langle L^2 \rangle = 0.31$	Xtrriage
Estimated twinning fraction	No twinning to report.	Xtrriage
$F_o, F_c$ correlation	0.94	EDS
Total number of atoms	10795	wwPDB-VP
Average B, all atoms (Å <sup>2</sup> )	92.0	wwPDB-VP

Xtrriage's analysis on translational NCS is as follows: *The largest off-origin peak in the Patterson function is 3.90% of the height of the origin peak. No significant pseudotranslation is detected.*

<sup>1</sup>Intensities estimated from amplitudes.

<sup>2</sup>Theoretical values of  $\langle |L| \rangle$ ,  $\langle L^2 \rangle$  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: 3QZ, 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	1.00	1/3621 (0.0%)	1.33	13/4927 (0.3%)
1	B	0.90	0/3617	1.26	14/4922 (0.3%)
1	C	0.99	2/3621 (0.1%)	1.35	13/4927 (0.3%)
All	All	0.96	3/10859 (0.0%)	1.31	40/14776 (0.3%)

All (3) bond length outliers are listed below:

Mol	Chain	Res	Type	Atoms	Z	Observed(Å)	Ideal(Å)
1	A	137	GLU	CA-C	5.83	1.59	1.52
1	C	406	TRP	C-O	-5.16	1.19	1.24
1	C	135	SER	N-CA	5.08	1.52	1.46

The worst 5 of 40 bond angle outliers are listed below:

Mol	Chain	Res	Type	Atoms	Z	Observed(°)	Ideal(°)
1	B	412	GLU	CA-C-N	-11.38	106.78	119.98
1	B	412	GLU	C-N-CA	-11.38	106.78	119.98
1	C	406	TRP	CA-C-N	11.30	131.16	119.19
1	C	406	TRP	C-N-CA	11.30	131.16	119.19
1	A	412	GLU	N-CA-C	9.74	126.99	113.16

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	3531	0	3586	71	0
1	B	3527	0	3583	57	0
1	C	3531	0	3586	79	0
2	A	43	0	30	2	0
2	B	43	0	30	4	0
2	C	43	0	30	1	0
3	A	24	0	30	3	0
3	B	24	0	30	0	0
3	C	24	0	30	1	0
4	A	1	0	0	0	0
4	B	4	0	0	0	0
All	All	10795	0	10935	204	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 10.

The worst 5 of 204 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:413:PRO:HG2	1:B:340:ARG:NH1	1.63	1.13
1:C:239:GLU:OE2	1:C:283:HIS:CE1	2.01	1.13
1:A:418:ARG:H	1:A:418:ARG:HD3	1.13	1.11
1:A:413:PRO:CG	1:B:340:ARG:HH11	1.66	1.09
1:C:129:LEU:O	1:C:133:ARG:HG2	1.56	1.03

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	436/476 (92%)	421 (97%)	13 (3%)	2 (0%)	24 56

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Mol	Chain	Analysed	Favoured	Allowed	Outliers	Percentiles
1	B	435/476 (91%)	416 (96%)	17 (4%)	2 (0%)	24 56
1	C	436/476 (92%)	420 (96%)	12 (3%)	4 (1%)	14 43
All	All	1307/1428 (92%)	1257 (96%)	42 (3%)	8 (1%)	21 52

5 of 8 Ramachandran outliers are listed below:

Mol	Chain	Res	Type
1	A	470	VAL
1	B	469	SER
1	C	470	VAL
1	A	184	ASP
1	B	184	ASP

### 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	386/415 (93%)	327 (85%)	59 (15%)	3 13
1	B	386/415 (93%)	334 (86%)	52 (14%)	4 16
1	C	386/415 (93%)	340 (88%)	46 (12%)	5 20
All	All	1158/1245 (93%)	1001 (86%)	157 (14%)	3 16

5 of 157 residues with a non-rotameric sidechain are listed below:

Mol	Chain	Res	Type
1	C	70	VAL
1	C	364	LEU
1	C	129	LEU
1	C	196	GLN
1	C	446	LEU

Sometimes sidechains can be flipped to improve hydrogen bonding and reduce clashes. 5 of 42 such sidechains are listed below:

Mol	Chain	Res	Type
1	C	196	GLN
1	C	315	GLN
1	C	221	ASN
1	C	241	GLN
1	C	347	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 oligosaccharides in this entry.

### 5.6 Ligand geometry [i](#)

6 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	3QZ	B	502	-	27,27,27	1.48	3 (11%)	44,45,45	2.05	14 (31%)
2	HEM	C	501	1	50,50,50	2.51	24 (48%)	67,82,82	2.01	17 (25%)
2	HEM	B	501	1	50,50,50	2.43	25 (50%)	67,82,82	1.97	17 (25%)
3	3QZ	A	502	-	27,27,27	1.43	1 (3%)	44,45,45	1.96	12 (27%)
3	3QZ	C	502	-	27,27,27	1.61	3 (11%)	44,45,45	1.98	14 (31%)
2	HEM	A	501	1	50,50,50	2.53	25 (50%)	67,82,82	1.93	15 (22%)

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	3QZ	B	502	-	-	5/6/68/68	0/4/4/4
2	HEM	C	501	1	-	0/14/54/54	-
2	HEM	B	501	1	-	0/14/54/54	-
3	3QZ	A	502	-	-	4/6/68/68	0/4/4/4
3	3QZ	C	502	-	-	2/6/68/68	0/4/4/4
2	HEM	A	501	1	-	0/14/54/54	-

The worst 5 of 81 bond length outliers are listed below:

Mol	Chain	Res	Type	Atoms	Z	Observed(Å)	Ideal(Å)
3	A	502	3QZ	CAA-CAP	-5.92	1.35	1.50
3	C	502	3QZ	CAA-CAP	-5.80	1.36	1.50
3	B	502	3QZ	CAA-CAP	-5.51	1.36	1.50
2	B	501	HEM	C4D-ND	-4.99	1.31	1.40
2	A	501	HEM	CHB-C1B	4.90	1.48	1.38

The worst 5 of 89 bond angle outliers are listed below:

Mol	Chain	Res	Type	Atoms	Z	Observed(°)	Ideal(°)
3	C	502	3QZ	CAW-CAX-CAP	6.78	121.03	112.93
2	A	501	HEM	C2D-C1D-ND	5.88	116.70	109.90
2	C	501	HEM	C3D-C4D-ND	5.87	116.61	110.17
3	B	502	3QZ	CAW-CAX-CAP	5.55	119.56	112.93
2	A	501	HEM	C1D-C2D-C3D	-5.28	101.43	106.98

There are no chirality outliers.

5 of 11 torsion outliers are listed below:

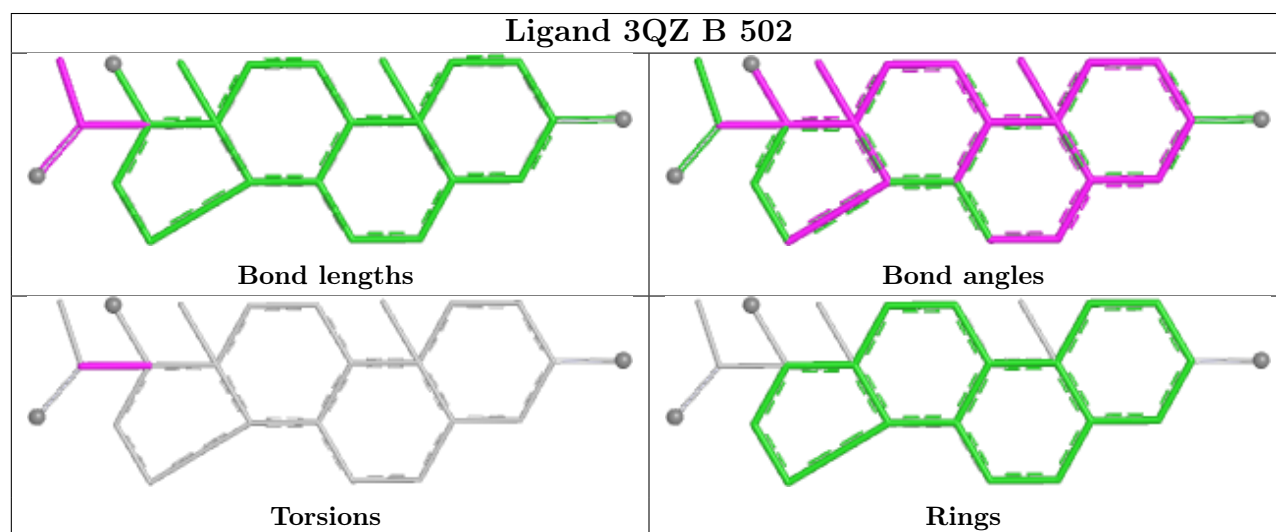
Mol	Chain	Res	Type	Atoms
3	A	502	3QZ	CAA-CAP-CAX-CAO
3	A	502	3QZ	OAD-CAP-CAX-CAO
3	C	502	3QZ	CAA-CAP-CAX-CAO
3	B	502	3QZ	OAD-CAP-CAX-OAF
3	A	502	3QZ	CAA-CAP-CAX-CAW

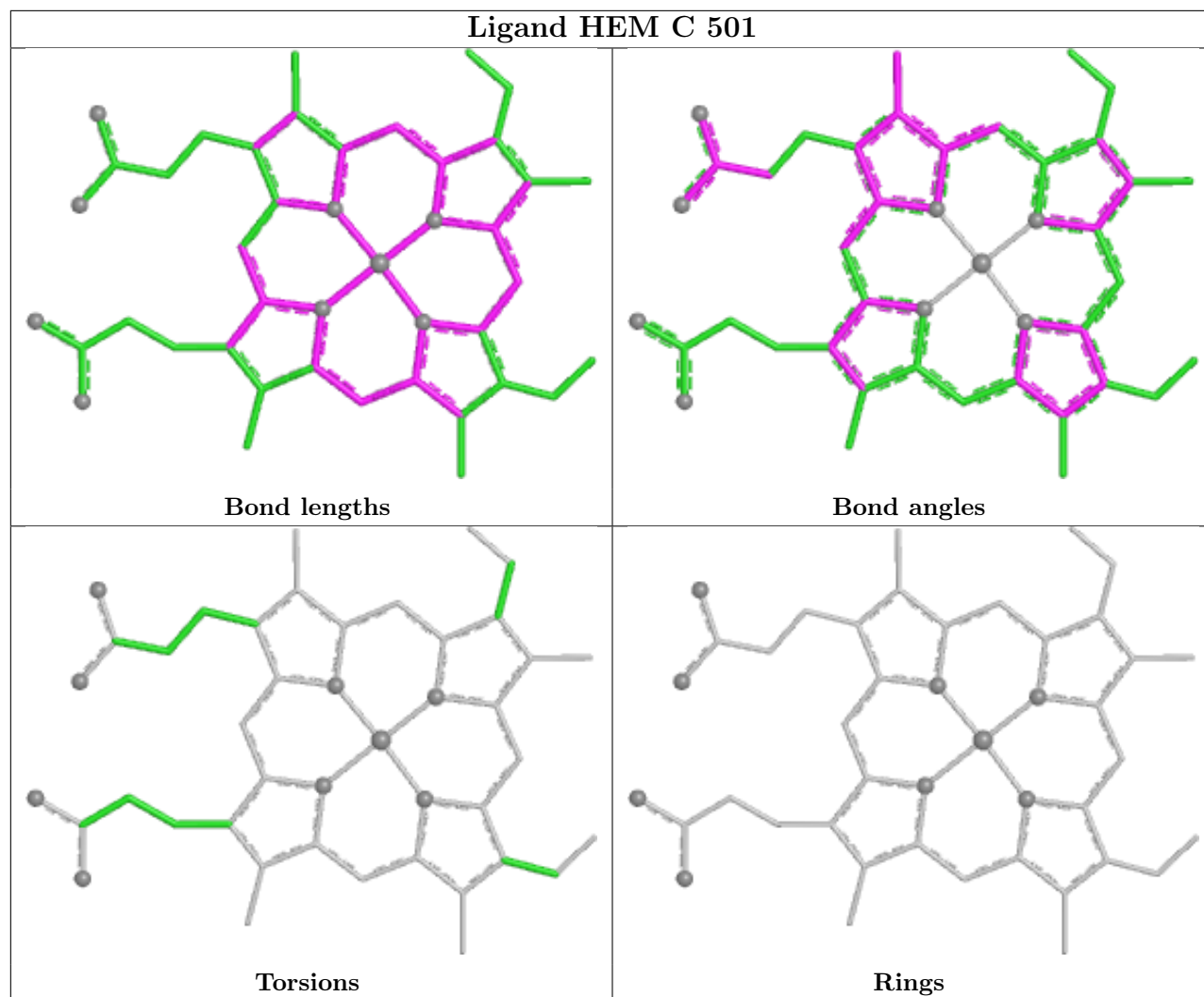
There are no ring outliers.

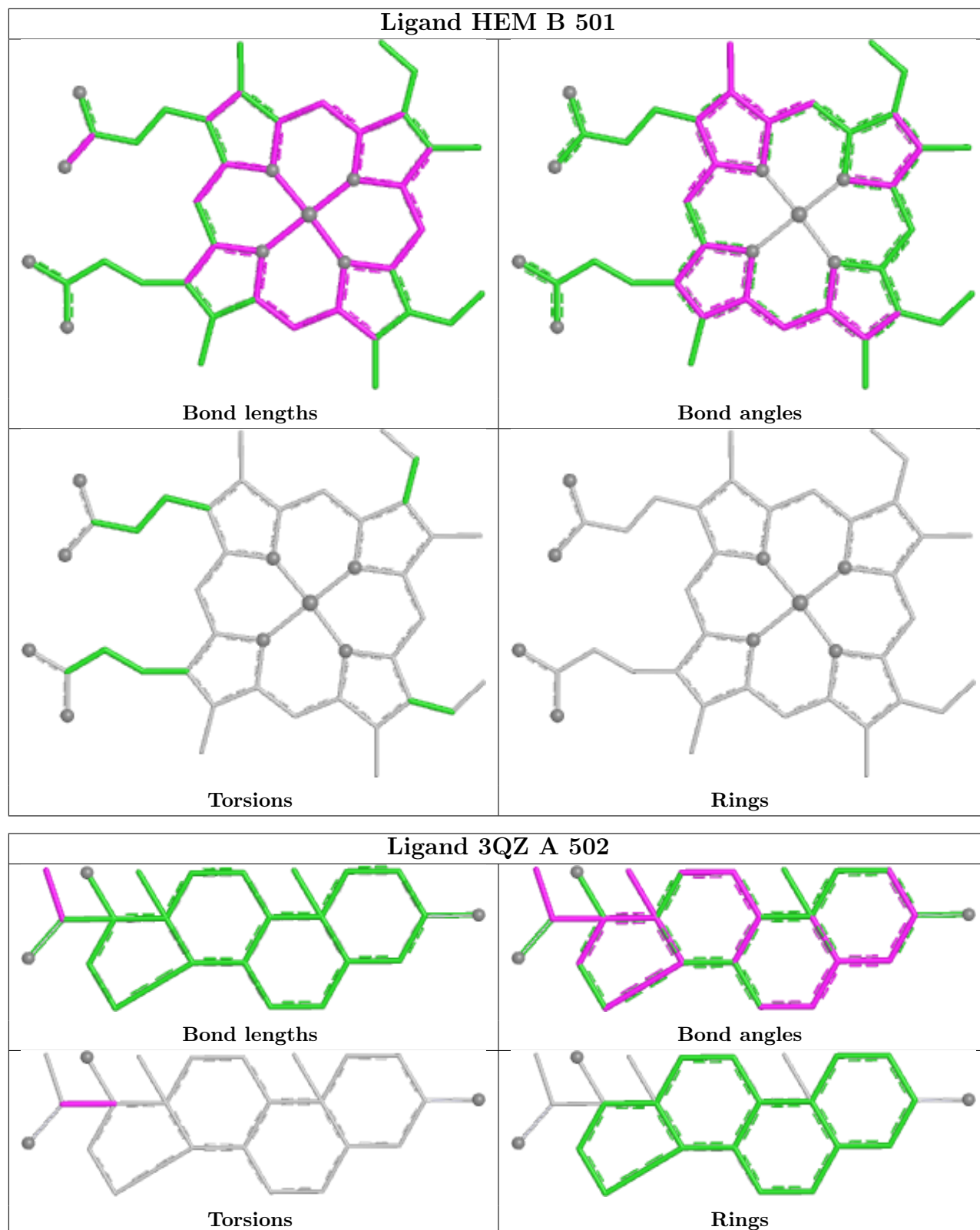
5 monomers are involved in 11 short contacts:

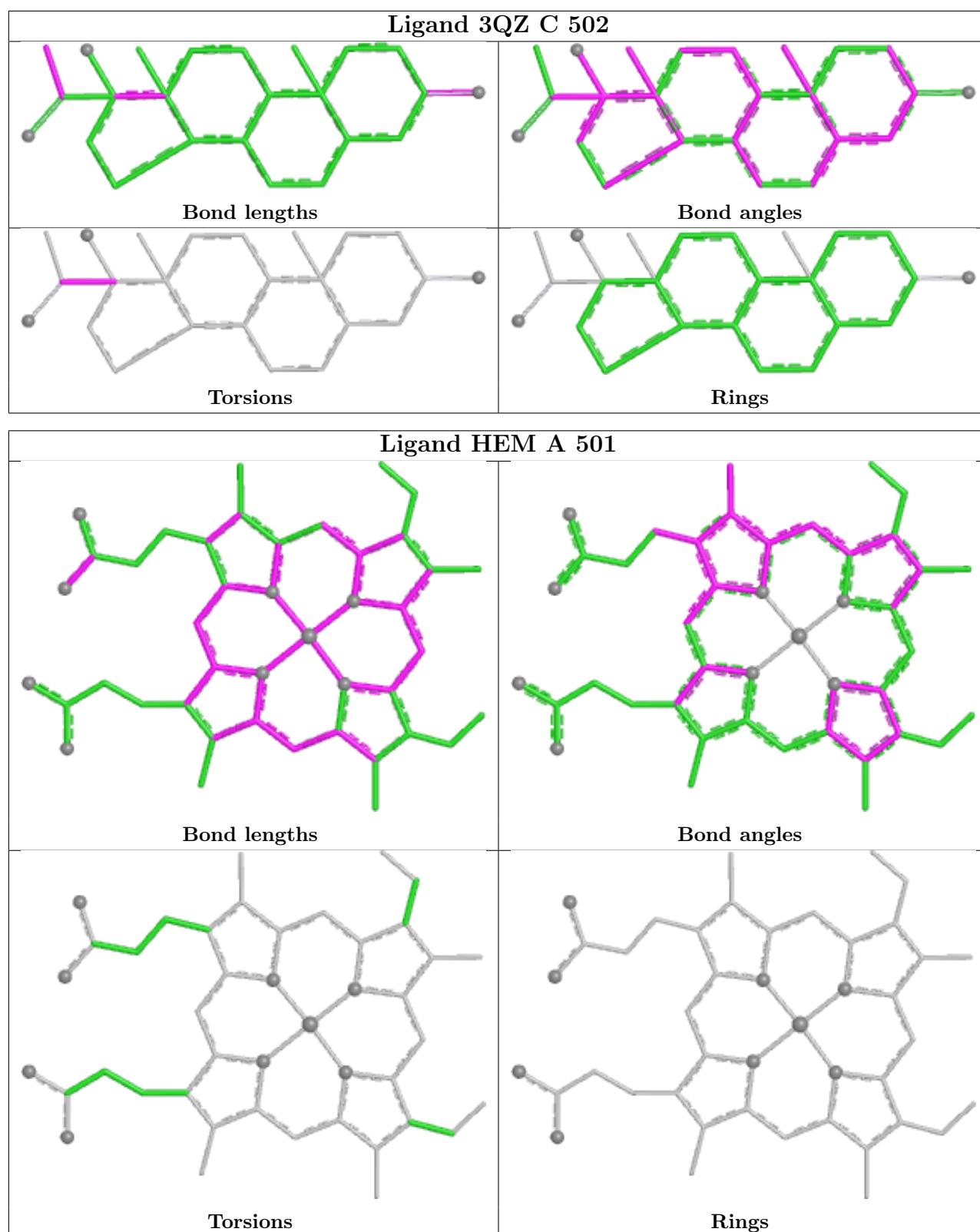
Mol	Chain	Res	Type	Clashes	Symm-Clashes
2	C	501	HEM	1	0
2	B	501	HEM	4	0
3	A	502	3QZ	3	0
3	C	502	3QZ	1	0
2	A	501	HEM	2	0

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

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, 95<sup>th</sup> 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 <sup>2</sup> )	Q<0.9
1	A	442/476 (92%)	-0.51	0 <a href="#">100</a> <a href="#">100</a>	45, 88, 122, 165	38 (8%)
1	B	441/476 (92%)	-0.43	0 <a href="#">100</a> <a href="#">100</a>	49, 89, 131, 177	27 (6%)
1	C	442/476 (92%)	-0.46	1 (0%) <a href="#">91</a> <a href="#">86</a>	44, 91, 122, 148	19 (4%)
All	All	1325/1428 (92%)	-0.47	1 (0%) <a href="#">92</a> <a href="#">91</a>	44, 89, 124, 177	84 (6%)

All (1) RSRZ outliers are listed below:

Mol	Chain	Res	Type	RSRZ
1	C	384	VAL	2.2

### 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 oligosaccharides 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, 95<sup>th</sup> 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.

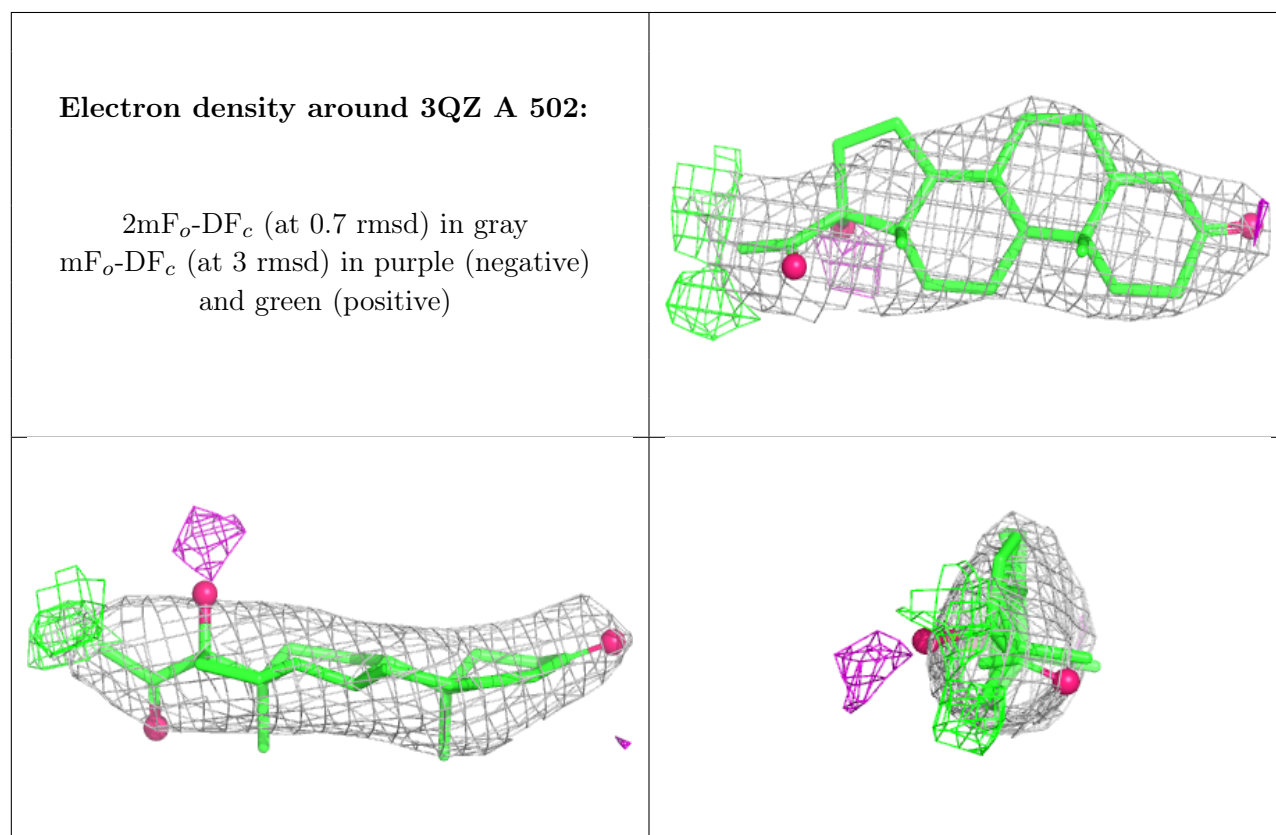
Mol	Type	Chain	Res	Atoms	RSCC	RSR	B-factors(Å <sup>2</sup> )	Q<0.9
3	3QZ	A	502	24/24	0.88	0.11	77,78,86,93	0
3	3QZ	C	502	24/24	0.92	0.12	80,86,95,103	0

*Continued on next page...*

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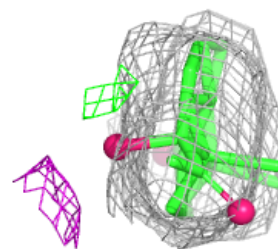
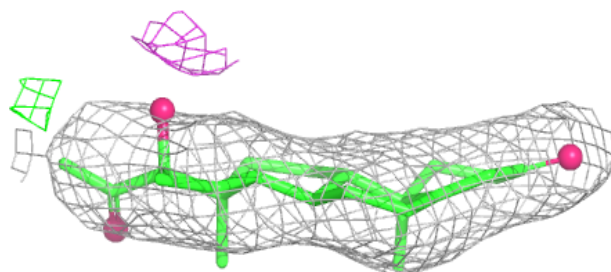
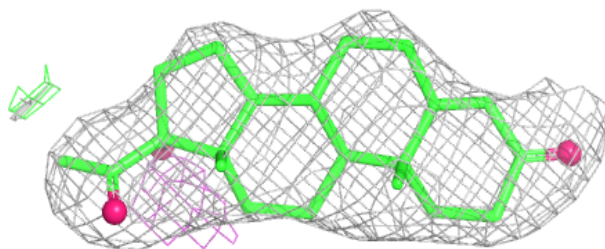
Mol	Type	Chain	Res	Atoms	RSCC	RSR	B-factors( $\text{\AA}^2$ )	Q<0.9
3	3QZ	B	502	24/24	0.94	0.10	77,80,85,91	0
2	HEM	C	501	43/43	0.96	0.09	84,98,102,104	0
2	HEM	A	501	43/43	0.96	0.10	77,91,97,99	0
2	HEM	B	501	43/43	0.97	0.08	85,100,104,116	0

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.

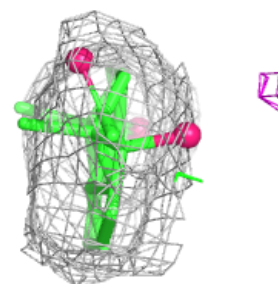
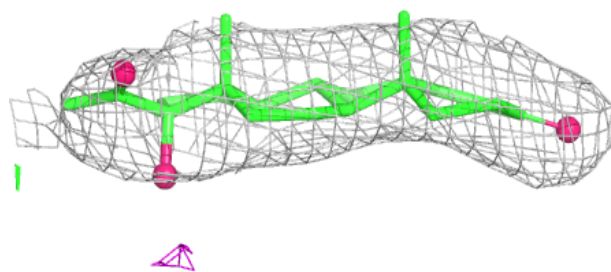
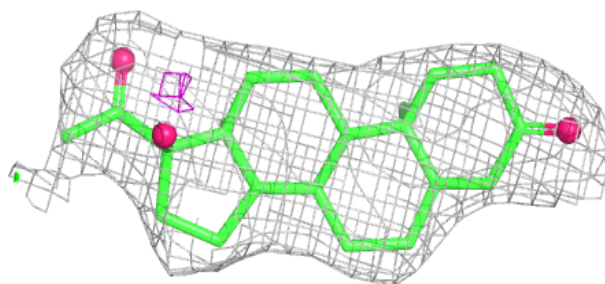


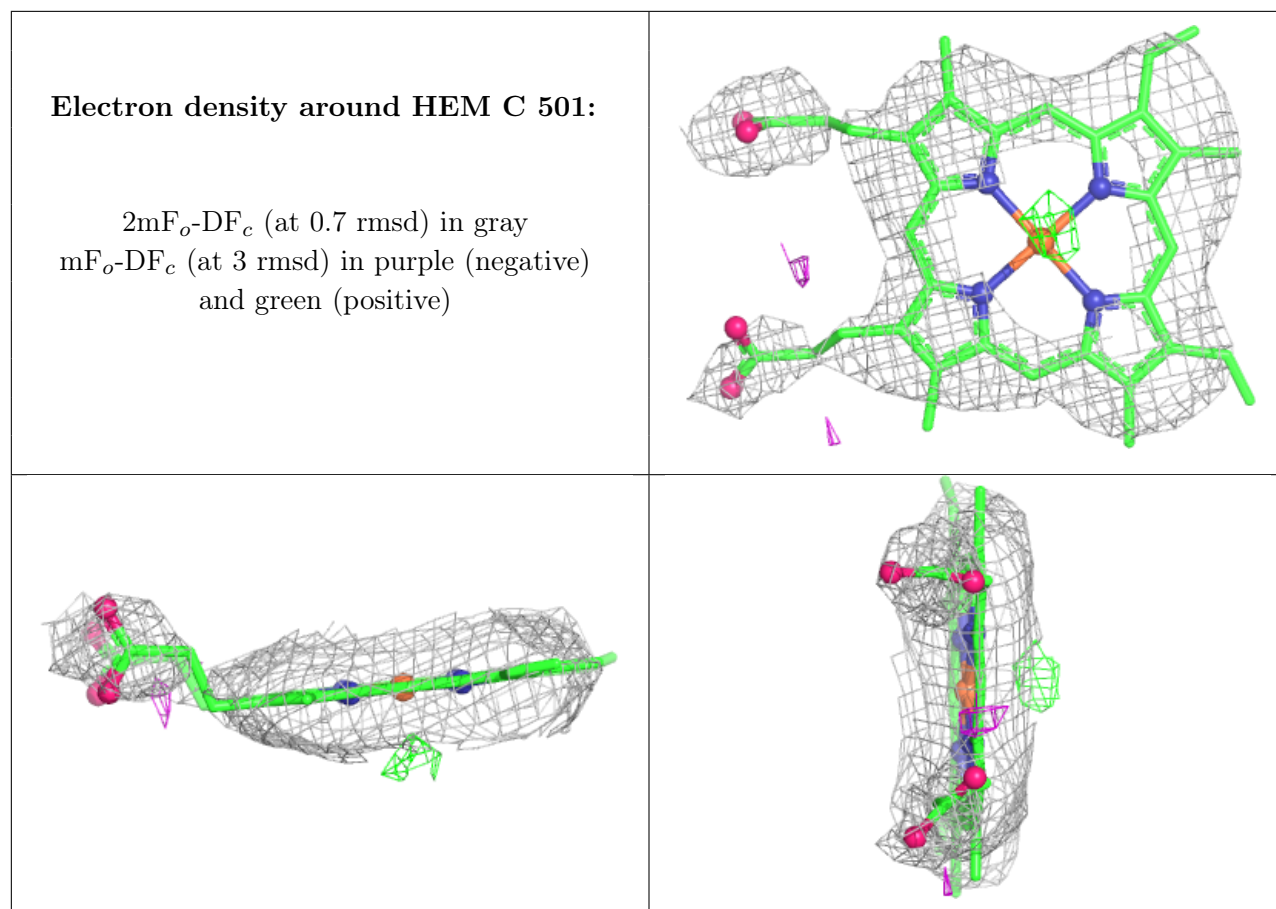
**Electron density around 3QZ C 502:**

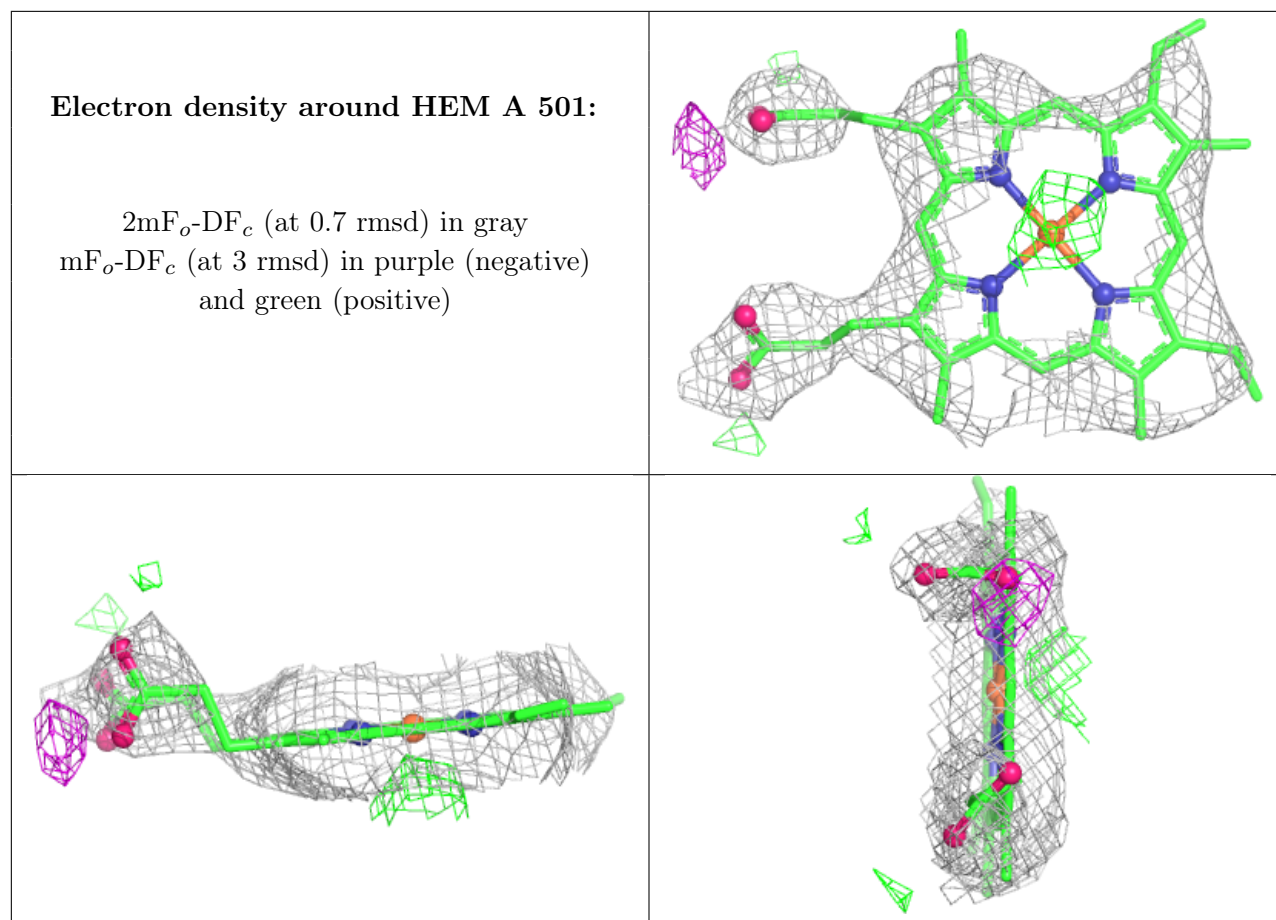
$2mF_o-DF_c$  (at 0.7 rmsd) in gray  
 $mF_o-DF_c$  (at 3 rmsd) in purple (negative)  
and green (positive)

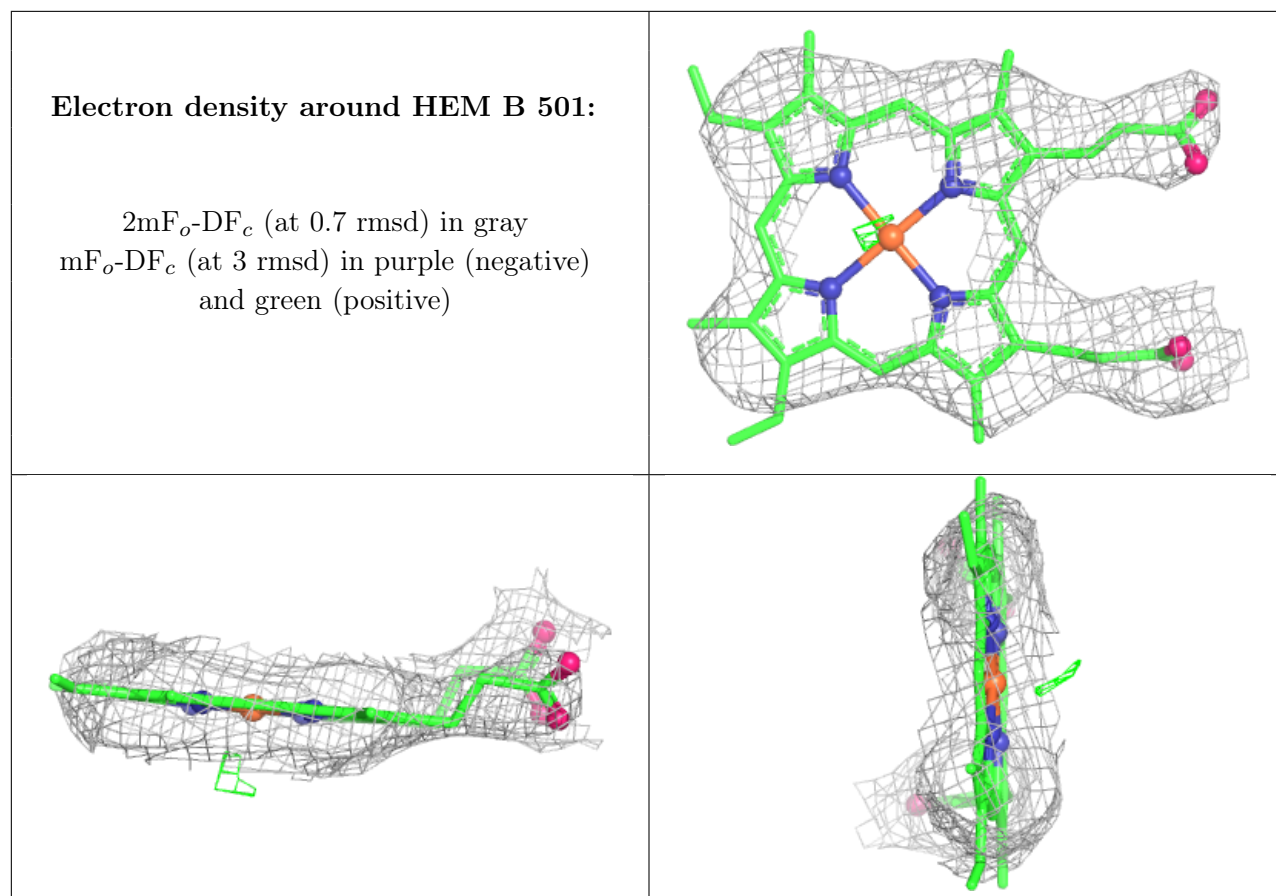
**Electron density around 3QZ B 502:**

$2mF_o-DF_c$  (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.