



Full wwPDB X-ray Structure Validation Report ⓘ

Mar 10, 2026 – 02:41 AM UTC

PDB ID : 6MCJ / pdb_00006mcj
Title : Structure of Helical Carotenoid Protein 2 from *Fremyella diplosiphon*
Authors : Sutter, M.; Dominguez-Martin, M.A.
Deposited on : 2018-08-31
Resolution : 1.71 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 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	:	4-5-2 with Phenix2.0
Mogul	:	2022.3.0, CSD as543be (2022)
Xtriage (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

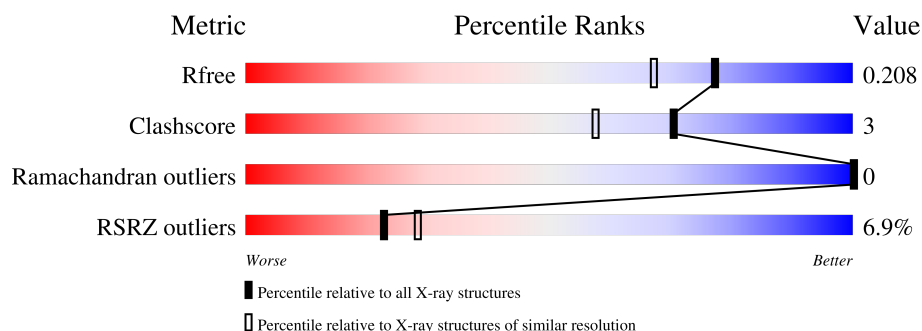
1 Overall quality at a glance

The following experimental techniques were used to determine the structure:

X-RAY DIFFRACTION

The reported resolution of this entry is 1.71 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	1039 (1.72-1.72)
Clashscore	190562	1049 (1.72-1.72)
Ramachandran outliers	187476	1041 (1.72-1.72)
RSRZ outliers	180081	1039 (1.72-1.72)

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 $\leq 5\%$. 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	163	
1	B	163	

2 Entry composition

There are 5 unique types of molecules in this entry. The entry contains 4951 atoms, of which 2377 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 Orange carotenoid-binding protein.

Mol	Chain	Residues	Atoms						ZeroOcc	AltConf	Trace
1	A	145	Total	C	H	N	O	S	0	0	0
			2274	726	1125	197	222	4			
1	B	145	Total	C	H	N	O	S	0	0	0
			2275	726	1126	197	222	4			

There are 28 discrepancies between the modelled and reference sequences:

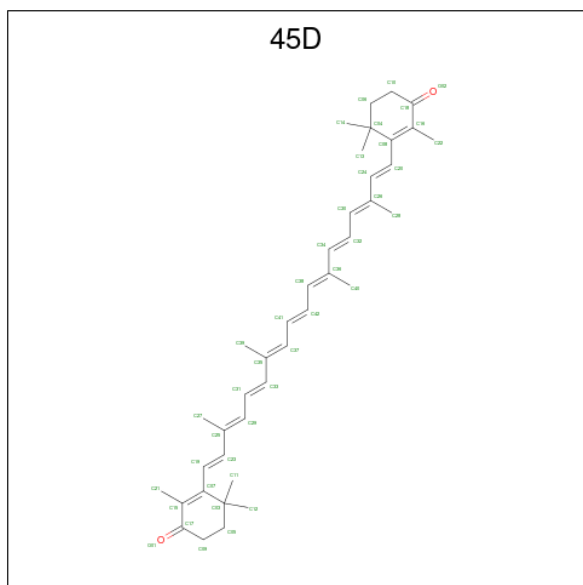
Chain	Residue	Modelled	Actual	Comment	Reference
A	149	GLY	-	expression tag	UNP A0A0D6L0Q7
A	150	SER	-	expression tag	UNP A0A0D6L0Q7
A	151	SER	-	expression tag	UNP A0A0D6L0Q7
A	152	ALA	-	expression tag	UNP A0A0D6L0Q7
A	153	HIS	-	expression tag	UNP A0A0D6L0Q7
A	154	HIS	-	expression tag	UNP A0A0D6L0Q7
A	155	HIS	-	expression tag	UNP A0A0D6L0Q7
A	156	HIS	-	expression tag	UNP A0A0D6L0Q7
A	157	HIS	-	expression tag	UNP A0A0D6L0Q7
A	158	HIS	-	expression tag	UNP A0A0D6L0Q7
A	159	HIS	-	expression tag	UNP A0A0D6L0Q7
A	160	HIS	-	expression tag	UNP A0A0D6L0Q7
A	161	HIS	-	expression tag	UNP A0A0D6L0Q7
A	162	HIS	-	expression tag	UNP A0A0D6L0Q7
B	149	GLY	-	expression tag	UNP A0A0D6L0Q7
B	150	SER	-	expression tag	UNP A0A0D6L0Q7
B	151	SER	-	expression tag	UNP A0A0D6L0Q7
B	152	ALA	-	expression tag	UNP A0A0D6L0Q7
B	153	HIS	-	expression tag	UNP A0A0D6L0Q7
B	154	HIS	-	expression tag	UNP A0A0D6L0Q7
B	155	HIS	-	expression tag	UNP A0A0D6L0Q7
B	156	HIS	-	expression tag	UNP A0A0D6L0Q7
B	157	HIS	-	expression tag	UNP A0A0D6L0Q7
B	158	HIS	-	expression tag	UNP A0A0D6L0Q7
B	159	HIS	-	expression tag	UNP A0A0D6L0Q7

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Chain	Residue	Modelled	Actual	Comment	Reference
B	160	HIS	-	expression tag	UNP A0A0D6L0Q7
B	161	HIS	-	expression tag	UNP A0A0D6L0Q7
B	162	HIS	-	expression tag	UNP A0A0D6L0Q7

- Molecule 2 is beta,beta-carotene-4,4'-dione (CCD ID: 45D) (formula: $C_{40}H_{52}O_2$).

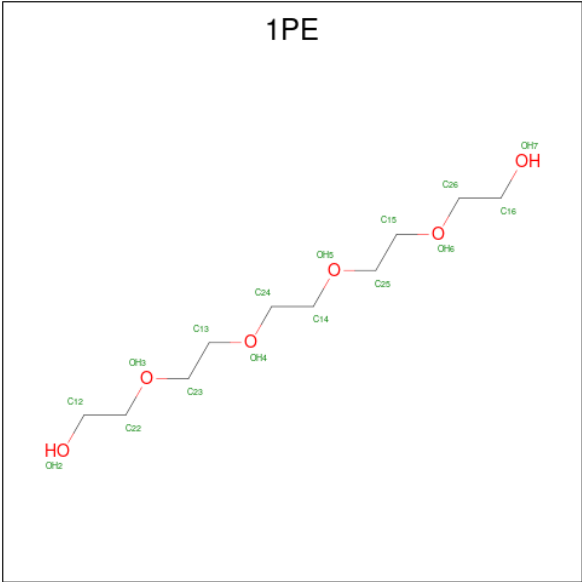


Mol	Chain	Residues	Atoms				ZeroOcc	AltConf
2	A	1	Total	C	H	O	0	0
			94	40	52	2		
2	B	1	Total	C	H	O	0	0
			94	40	52	2		

- Molecule 3 is IODIDE ION (CCD ID: IOD) (formula: I).

Mol	Chain	Residues	Atoms		ZeroOcc	AltConf
3	A	4	Total	I	0	0
			4	4		
3	B	4	Total	I	0	0
			4	4		

- Molecule 4 is PENTAETHYLENE GLYCOL (CCD ID: 1PE) (formula: $C_{10}H_{22}O_6$).



Mol	Chain	Residues	Atoms				ZeroOcc	AltConf
4	A	1	Total	C	H	O	0	0
			38	10	22	6		

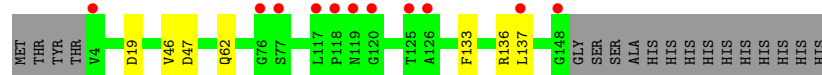
- Molecule 5 is water.

Mol	Chain	Residues	Atoms		ZeroOcc	AltConf
5	A	95	Total	O	0	0
			95	95		
5	B	73	Total	O	0	0
			73	73		

- Molecule 1: Orange carotenoid-binding protein



- Chain B:  7% 85% 11%



4 Data and refinement statistics

Property	Value	Source
Space group	P 1 21 1	Depositor
Cell constants a, b, c, α , β , γ	35.16Å 71.64Å 56.34Å 90.00° 92.32° 90.00°	Depositor
Resolution (Å)	44.26 – 1.71 44.26 – 1.71	Depositor EDS
% Data completeness (in resolution range)	94.0 (44.26-1.71) 92.5 (44.26-1.71)	Depositor EDS
R_{merge}	0.04	Depositor
R_{sym}	(Not available)	Depositor
$\langle I/\sigma(I) \rangle$ ¹	2.22 (at 1.71Å)	Xtriage
Refinement program	PHENIX (1.13_2998: ???)	Depositor
R, R_{free}	0.167 , 0.199 (Not available) , 0.208	Depositor DCC
R_{free} test set	1882 reflections (6.24%)	wwPDB-VP
Wilson B-factor (Å ²)	21.7	Xtriage
Anisotropy	0.187	Xtriage
Bulk solvent k_{sol} (e/Å ³), B_{sol} (Å ²)	0.41 , 38.4	EDS
L-test for twinning ²	$\langle L \rangle = 0.49$, $\langle L^2 \rangle = 0.33$	Xtriage
Estimated twinning fraction	0.042 for h,-k,-l	Xtriage
F_o, F_c correlation	0.96	EDS
Total number of atoms	4951	wwPDB-VP
Average B, all atoms (Å ²)	29.0	wwPDB-VP

Xtriage's analysis on translational NCS is as follows: *The largest off-origin peak in the Patterson function is 10.67% of the height of the origin peak. No significant pseudotranslation is detected.*

¹Intensities estimated from amplitudes.

²Theoretical 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: IOD, 1PE, 45D

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	0.22	0/1173	0.35	0/1594
1	B	0.20	0/1173	0.33	0/1594
All	All	0.21	0/2346	0.34	0/3188

There are no bond length outliers.

There are no bond angle outliers.

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	1149	1125	1125	8	0
1	B	1149	1126	1125	5	0
2	A	42	52	52	1	0
2	B	42	52	52	2	0
3	A	4	0	0	0	0
3	B	4	0	0	0	0
4	A	16	22	22	0	0
5	A	95	0	0	2	1
5	B	73	0	0	3	1
All	All	2574	2377	2376	16	1

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 3.

All (16) 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:45:SER:O	5:A:301:HOH:O	2.02	0.76
1:B:136:ARG:NH1	5:B:301:HOH:O	2.20	0.75
1:A:82:ARG:NH1	5:A:303:HOH:O	2.24	0.70
1:A:43:PRO:HG2	1:A:48:THR:HG21	1.76	0.68
2:B:201:45D:H231	2:B:201:45D:H122	1.82	0.62
1:A:20:VAL:HG21	1:A:74:LYS:HG3	1.83	0.59
2:A:201:45D:H231	2:A:201:45D:H122	1.85	0.59
1:A:87:LEU:O	1:A:92:LYS:NZ	2.38	0.56
1:B:133:PHE:CE2	1:B:137:LEU:HD11	2.45	0.52
2:B:201:45D:H221	2:B:201:45D:H241	1.95	0.47
1:A:12:LEU:HD13	1:A:12:LEU:C	2.40	0.46
1:A:77:SER:O	1:A:82:ARG:NH1	2.45	0.43
1:B:62:GLN:NE2	5:B:305:HOH:O	2.38	0.42
1:B:19:ASP:OD1	5:B:302:HOH:O	2.21	0.42
1:A:9:ARG:N	1:A:10:PRO:HD2	2.36	0.41
1:B:46:VAL:HG23	1:B:47:ASP:OD1	2.22	0.40

All (1) 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)
5:A:370:HOH:O	5:B:322:HOH:O[2_655]	2.18	0.02

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	5/163 (3%)	4 (80%)	1 (20%)	0	100	100

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Mol	Chain	Analysed	Favoured	Allowed	Outliers	Percentiles	
1	B	81/163 (50%)	80 (99%)	1 (1%)	0	100	100
All	All	86/326 (26%)	84 (98%)	2 (2%)	0	100	100

There are no Ramachandran outliers to report.

5.3.2 Protein sidechains [i](#)

There are no protein residues with a non-rotameric sidechain to report in this entry.

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](#)

Of 11 ligands modelled in this entry, 8 are monoatomic - leaving 3 for Mogul analysis.

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	1PE	A	206	-	15,15,15	0.54	0	14,14,14	0.31	0
2	45D	A	201	-	43,43,43	0.79	0	54,60,60	1.77	16 (29%)
2	45D	B	201	-	43,43,43	0.82	1 (2%)	54,60,60	1.72	15 (27%)

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	1PE	A	206	-	-	8/13/13/13	-
2	45D	A	201	-	-	2/29/69/69	0/2/2/2
2	45D	B	201	-	-	2/29/69/69	0/2/2/2

All (1) bond length outliers are listed below:

Mol	Chain	Res	Type	Atoms	Z	Observed(Å)	Ideal(Å)
2	B	201	45D	C04-C08	-3.00	1.49	1.53

All (31) bond angle outliers are listed below:

Mol	Chain	Res	Type	Atoms	Z	Observed(°)	Ideal(°)
2	A	201	45D	C05-C09-C17	-4.22	105.00	112.71
2	B	201	45D	C05-C09-C17	-3.85	105.67	112.71
2	B	201	45D	C06-C04-C08	-3.71	105.05	110.44
2	B	201	45D	C23-C25-C29	3.29	124.19	119.01
2	A	201	45D	C09-C17-C15	-3.22	115.75	118.64
2	A	201	45D	C23-C25-C29	3.18	124.01	119.01
2	A	201	45D	C33-C35-C37	3.09	123.87	119.01
2	B	201	45D	C24-C26-C30	2.86	123.51	119.01
2	A	201	45D	C06-C10-C18	-2.85	107.50	112.71
2	B	201	45D	C13-C04-C08	2.83	114.68	110.24
2	A	201	45D	C24-C26-C30	2.65	123.17	119.01
2	A	201	45D	C13-C04-C08	2.62	114.36	110.24
2	B	201	45D	C33-C35-C37	2.62	123.13	119.01
2	B	201	45D	C42-C38-C36	2.60	130.93	127.28
2	A	201	45D	C42-C41-C37	2.59	128.82	123.52
2	B	201	45D	C09-C17-C15	-2.56	116.35	118.64
2	B	201	45D	C41-C37-C35	2.50	130.79	127.28
2	B	201	45D	C10-C06-C04	-2.46	109.60	113.21
2	A	201	45D	C20-C24-C26	2.44	129.84	126.23
2	A	201	45D	C42-C38-C36	2.42	130.67	127.28
2	A	201	45D	C32-C30-C26	2.30	130.50	127.28
2	B	201	45D	C34-C36-C38	2.26	122.56	119.01
2	B	201	45D	C42-C41-C37	2.24	128.09	123.52
2	A	201	45D	C34-C36-C38	2.13	122.36	119.01
2	A	201	45D	C32-C34-C36	2.09	132.10	126.36
2	B	201	45D	C32-C30-C26	2.08	130.20	127.28

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Mol	Chain	Res	Type	Atoms	Z	Observed(°)	Ideal(°)
2	A	201	45D	C14-C04-C13	-2.07	102.72	108.63
2	B	201	45D	C06-C10-C18	-2.07	108.93	112.71
2	A	201	45D	C06-C04-C08	-2.05	107.46	110.44
2	A	201	45D	C41-C37-C35	2.04	130.14	127.28
2	B	201	45D	C32-C34-C36	2.03	131.92	126.36

There are no chirality outliers.

All (12) torsion outliers are listed below:

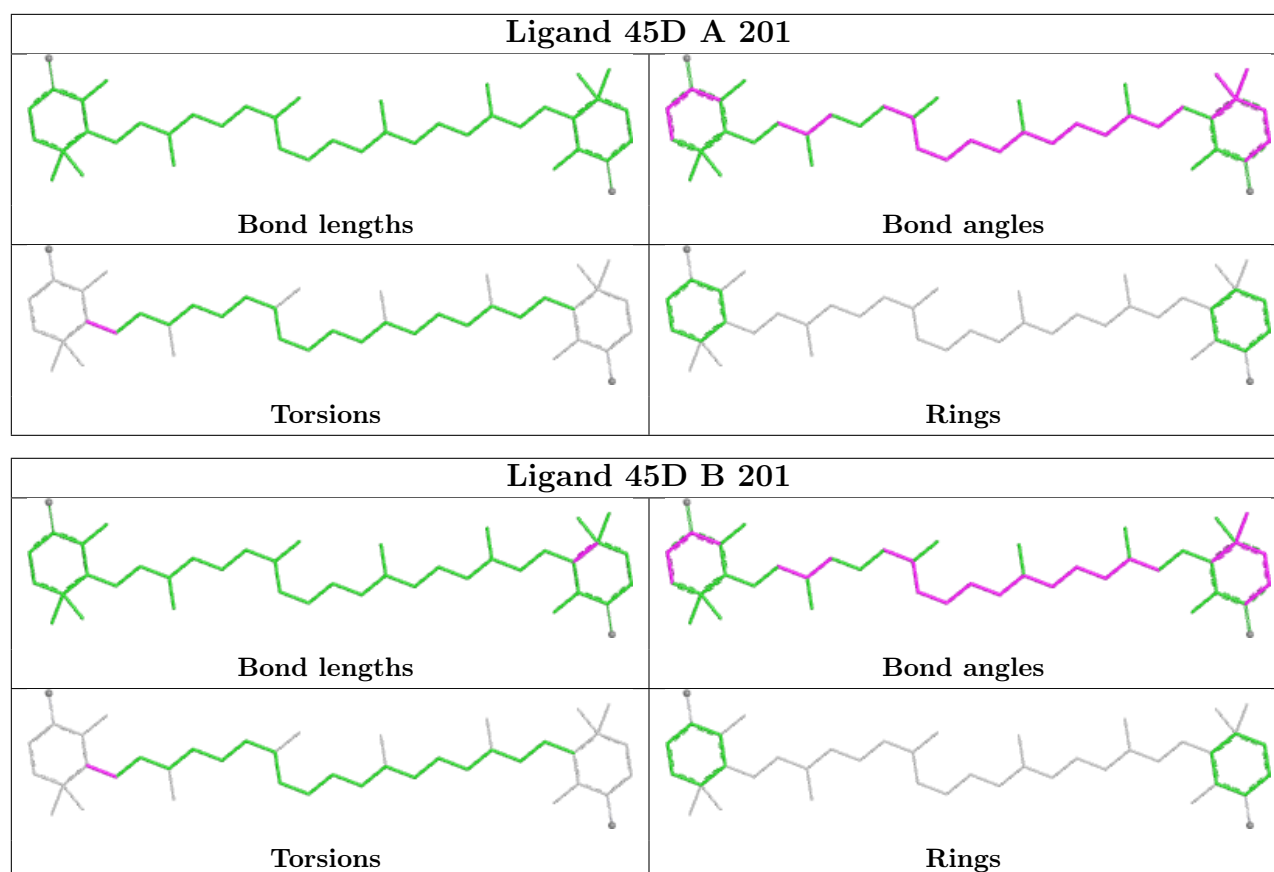
Mol	Chain	Res	Type	Atoms
4	A	206	1PE	OH5-C14-C24-OH4
4	A	206	1PE	OH6-C15-C25-OH5
2	A	201	45D	C03-C07-C19-C23
2	B	201	45D	C03-C07-C19-C23
4	A	206	1PE	OH2-C12-C22-OH3
4	A	206	1PE	C25-C15-OH6-C26
4	A	206	1PE	C23-C13-OH4-C24
4	A	206	1PE	C13-C23-OH3-C22
4	A	206	1PE	C15-C25-OH5-C14
2	B	201	45D	C15-C07-C19-C23
4	A	206	1PE	C12-C22-OH3-C23
2	A	201	45D	C15-C07-C19-C23

There are no ring outliers.

2 monomers are involved in 3 short contacts:

Mol	Chain	Res	Type	Clashes	Symm-Clashes
2	A	201	45D	1	0
2	B	201	45D	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 [i](#)

There are no chain breaks in this entry.

6 Fit of model and data

6.1 Protein, DNA and RNA chains

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, 95th 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 ²)	Q<0.9
1	A	145/163 (88%)	0.08	9 (6%) 26 32	14, 24, 55, 94	0
1	B	145/163 (88%)	0.19	11 (7%) 20 25	14, 26, 55, 67	0
All	All	290/326 (88%)	0.13	20 (6%) 23 28	14, 26, 57, 94	0

All (20) RSRZ outliers are listed below:

Mol	Chain	Res	Type	RSRZ
1	A	148	GLY	4.6
1	A	47	ASP	4.1
1	B	77	SER	4.0
1	A	43	PRO	3.8
1	A	42	PRO	3.2
1	A	44	ASN	3.1
1	B	4	VAL	3.1
1	A	46	VAL	3.0
1	B	148	GLY	3.0
1	A	48	THR	2.8
1	B	137	LEU	2.6
1	B	76	GLY	2.5
1	B	119	ASN	2.4
1	B	120	GLY	2.3
1	B	125	THR	2.3
1	B	117	LEU	2.3
1	B	118	PRO	2.2
1	A	7	SER	2.0
1	B	126	ALA	2.0
1	A	45	SER	2.0

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](#)

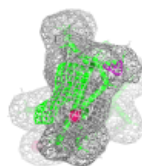
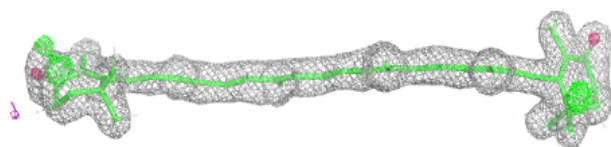
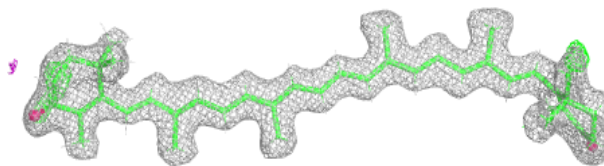
In the following table, the Atoms column lists the number of modelled atoms in the group and the number defined in the chemical component dictionary. The B-factors column lists the minimum, median, 95th percentile and maximum values of B factors of atoms in the group. The column labelled 'Q< 0.9' lists the number of atoms with occupancy less than 0.9.

Mol	Type	Chain	Res	Atoms	RSCC	RSR	B-factors($\text{\AA}^2$)	Q<0.9
4	1PE	A	206	16/16	0.86	0.13	29,44,52,52	0
3	IOD	B	205	1/1	0.92	0.14	92,92,92,92	1
3	IOD	A	205	1/1	0.93	0.08	44,44,44,44	1
2	45D	A	201	42/42	0.94	0.07	12,22,35,39	0
2	45D	B	201	42/42	0.95	0.07	10,20,41,50	0
3	IOD	A	203	1/1	0.96	0.07	39,39,39,39	1
3	IOD	B	204	1/1	0.96	0.07	34,34,34,34	1
3	IOD	B	203	1/1	0.98	0.04	33,33,33,33	1
3	IOD	B	202	1/1	0.98	0.03	21,21,21,21	1
3	IOD	A	202	1/1	0.99	0.03	24,24,24,24	1
3	IOD	A	204	1/1	0.99	0.03	21,21,21,21	1

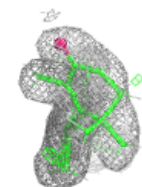
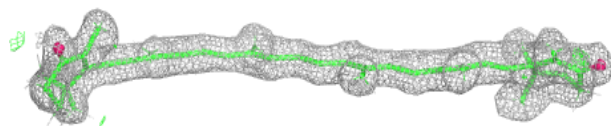
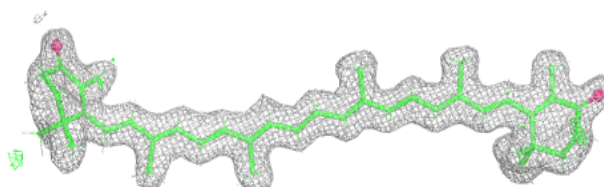
The following is a graphical depiction of the model fit to experimental electron density of all instances of the Ligand of Interest. In addition, ligands with molecular weight > 250 and outliers as shown on the geometry validation Tables will also be included. Each fit is shown from different orientation to approximate a three-dimensional view.

Electron density around 45D A 201:

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

**Electron density around 45D B 201:**

$2mF_o-DF_c$ (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.