



Full wwPDB X-ray Structure Validation Report ⓘ

Aug 18, 2026 – 10:23 am BST

PDB ID : 5M3B / pdb_00005m3b
Title : Structure of cobinamide-bound BtuF mutant W66L, the periplasmic vitamin B12 binding protein in E.coli
Authors : Mireku, S.A.; Ruetz, M.; Zhou, T.; Korkhov, V.M.; Kraeutler, B.; Locher, K.P.
Deposited on : 2016-10-14
Resolution : 1.50 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	:	1.8.4, CSD as541be (2020)
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	:	9.0.015 (Gargrove)
Density-Fitness	:	1.0.12
Ideal geometry (proteins)	:	Engh & Huber (2001)
Ideal geometry (DNA, RNA)	:	Parkinson et al. (1996)
Validation Pipeline (wwPDB-VP)	:	2.50

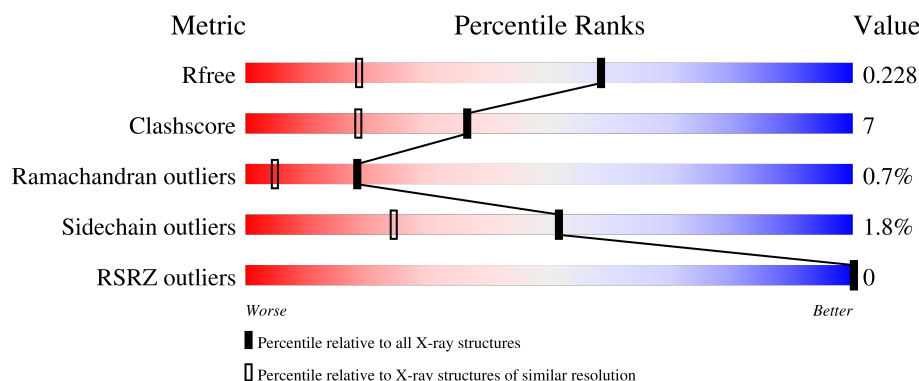
1 Overall quality at a glance

The following experimental techniques were used to determine the structure:

X-RAY DIFFRACTION

The reported resolution of this entry is 1.50 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	4037 (1.50-1.50)
Clashscore	190562	4235 (1.50-1.50)
Ramachandran outliers	187476	4153 (1.50-1.50)
Sidechain outliers	187428	4150 (1.50-1.50)
RSRZ outliers	180081	4039 (1.50-1.50)

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	289	 70% 8% • 21%
1	B	289	 68% 10% • 20%

The following table lists non-polymeric compounds, carbohydrate monomers and non-standard residues in protein, DNA, RNA chains that are outliers for geometric or electron-density-fit criteria:

Mol	Type	Chain	Res	Chirality	Geometry	Clashes	Electron density
2	CYN	A	301	-	-	X	-
4	GOL	B	304	-	-	X	-

2 Entry composition

There are 5 unique types of molecules in this entry. The entry contains 4266 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 Vitamin B12-binding protein.

Mol	Chain	Residues	Atoms					ZeroOcc	AltConf	Trace
1	A	228	Total	C	N	O	S	0	0	0
			1762	1120	308	330	4			
1	B	230	Total	C	N	O	S	0	1	0
			1783	1133	313	332	5			

There are 90 discrepancies between the modelled and reference sequences:

Chain	Residue	Modelled	Actual	Comment	Reference
A	-2	MET	-	initiating methionine	UNP P37028
A	-1	LYS	-	expression tag	UNP P37028
A	0	LYS	-	expression tag	UNP P37028
A	1	THR	-	expression tag	UNP P37028
A	2	ALA	-	expression tag	UNP P37028
A	3	ILE	-	expression tag	UNP P37028
A	4	ALA	-	expression tag	UNP P37028
A	5	ILE	-	expression tag	UNP P37028
A	6	ALA	-	expression tag	UNP P37028
A	7	VAL	-	expression tag	UNP P37028
A	8	ALA	-	expression tag	UNP P37028
A	9	LEU	-	expression tag	UNP P37028
A	10	ALA	-	expression tag	UNP P37028
A	11	GLY	-	expression tag	UNP P37028
A	12	PHE	-	expression tag	UNP P37028
A	13	ALA	-	expression tag	UNP P37028
A	14	THR	-	expression tag	UNP P37028
A	15	VAL	-	expression tag	UNP P37028
A	16	ALA	-	expression tag	UNP P37028
A	17	GLN	-	expression tag	UNP P37028
A	18	ALA	-	expression tag	UNP P37028
A	19	ALA	-	expression tag	UNP P37028
A	20	SER	-	expression tag	UNP P37028
A	21	MET	-	expression tag	UNP P37028
A	66	LEU	TRP	engineered mutation	UNP P37028

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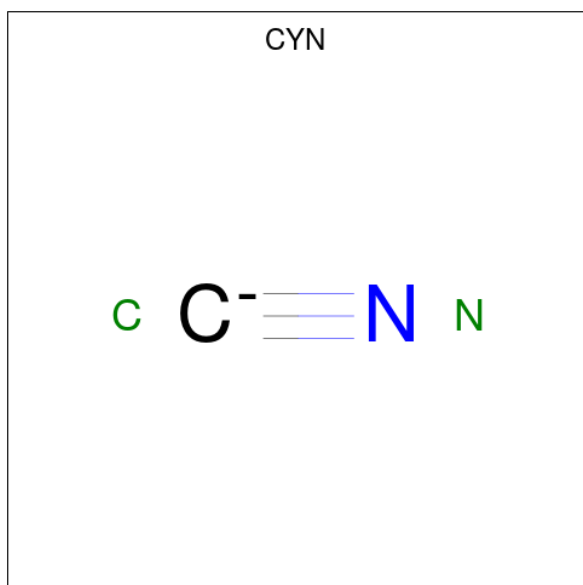
Chain	Residue	Modelled	Actual	Comment	Reference
A	267	SER	-	expression tag	UNP P37028
A	268	GLY	-	expression tag	UNP P37028
A	269	SER	-	expression tag	UNP P37028
A	270	LEU	-	expression tag	UNP P37028
A	271	GLU	-	expression tag	UNP P37028
A	272	VAL	-	expression tag	UNP P37028
A	273	LEU	-	expression tag	UNP P37028
A	274	PHE	-	expression tag	UNP P37028
A	275	GLN	-	expression tag	UNP P37028
A	276	GLY	-	expression tag	UNP P37028
A	277	PRO	-	expression tag	UNP P37028
A	278	GLY	-	expression tag	UNP P37028
A	279	GLY	-	expression tag	UNP P37028
A	280	SER	-	expression tag	UNP P37028
A	281	HIS	-	expression tag	UNP P37028
A	282	HIS	-	expression tag	UNP P37028
A	283	HIS	-	expression tag	UNP P37028
A	284	HIS	-	expression tag	UNP P37028
A	285	HIS	-	expression tag	UNP P37028
A	286	HIS	-	expression tag	UNP P37028
B	-2	MET	-	initiating methionine	UNP P37028
B	-1	LYS	-	expression tag	UNP P37028
B	0	LYS	-	expression tag	UNP P37028
B	1	THR	-	expression tag	UNP P37028
B	2	ALA	-	expression tag	UNP P37028
B	3	ILE	-	expression tag	UNP P37028
B	4	ALA	-	expression tag	UNP P37028
B	5	ILE	-	expression tag	UNP P37028
B	6	ALA	-	expression tag	UNP P37028
B	7	VAL	-	expression tag	UNP P37028
B	8	ALA	-	expression tag	UNP P37028
B	9	LEU	-	expression tag	UNP P37028
B	10	ALA	-	expression tag	UNP P37028
B	11	GLY	-	expression tag	UNP P37028
B	12	PHE	-	expression tag	UNP P37028
B	13	ALA	-	expression tag	UNP P37028
B	14	THR	-	expression tag	UNP P37028
B	15	VAL	-	expression tag	UNP P37028
B	16	ALA	-	expression tag	UNP P37028
B	17	GLN	-	expression tag	UNP P37028
B	18	ALA	-	expression tag	UNP P37028
B	19	ALA	-	expression tag	UNP P37028

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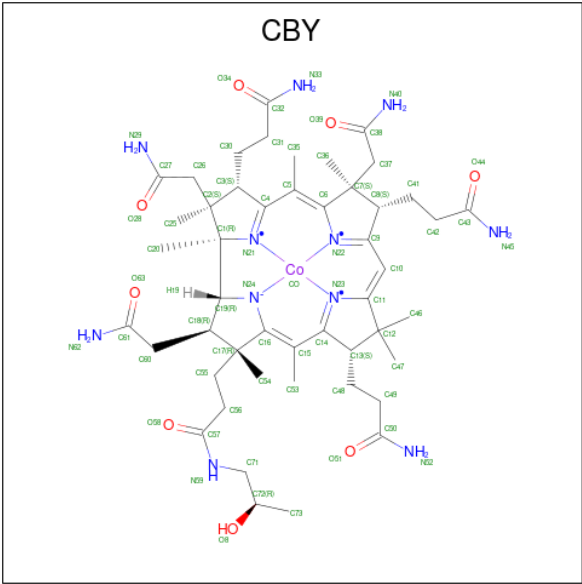
Chain	Residue	Modelled	Actual	Comment	Reference
B	20	SER	-	expression tag	UNP P37028
B	21	MET	-	expression tag	UNP P37028
B	66	LEU	TRP	engineered mutation	UNP P37028
B	267	SER	-	expression tag	UNP P37028
B	268	GLY	-	expression tag	UNP P37028
B	269	SER	-	expression tag	UNP P37028
B	270	LEU	-	expression tag	UNP P37028
B	271	GLU	-	expression tag	UNP P37028
B	272	VAL	-	expression tag	UNP P37028
B	273	LEU	-	expression tag	UNP P37028
B	274	PHE	-	expression tag	UNP P37028
B	275	GLN	-	expression tag	UNP P37028
B	276	GLY	-	expression tag	UNP P37028
B	277	PRO	-	expression tag	UNP P37028
B	278	GLY	-	expression tag	UNP P37028
B	279	GLY	-	expression tag	UNP P37028
B	280	SER	-	expression tag	UNP P37028
B	281	HIS	-	expression tag	UNP P37028
B	282	HIS	-	expression tag	UNP P37028
B	283	HIS	-	expression tag	UNP P37028
B	284	HIS	-	expression tag	UNP P37028
B	285	HIS	-	expression tag	UNP P37028
B	286	HIS	-	expression tag	UNP P37028

- Molecule 2 is CYANIDE ION (CCD ID: CYN) (formula: CN).



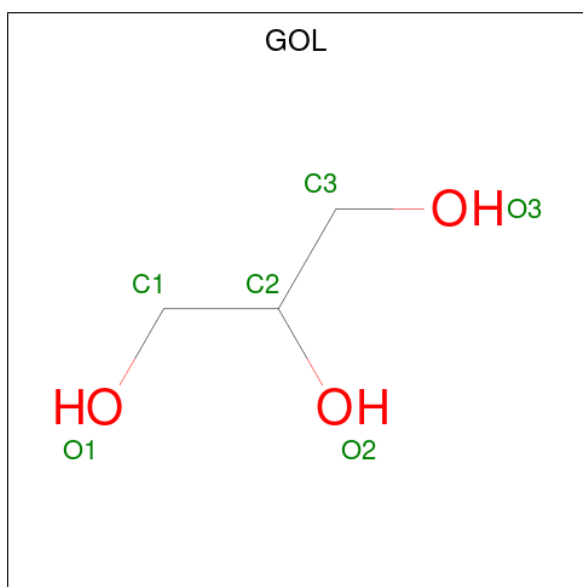
Mol	Chain	Residues	Atoms			ZeroOcc	AltConf
2	A	1	Total	C	N	0	0
			2	1	1		
2	A	1	Total	C	N	0	0
			2	1	1		
2	B	1	Total	C	N	0	0
			2	1	1		

- Molecule 3 is COB(II)INAMIDE (CCD ID: CBY) (formula: C₄₈H₇₂CoN₁₁O₈).



Mol	Chain	Residues	Atoms					ZeroOcc	AltConf
3	A	1	Total	C	Co	N	O	0	0
			68	48	1	11	8		
3	B	1	Total	C	Co	N	O	0	0
			68	48	1	11	8		

- Molecule 4 is GLYCEROL (CCD ID: GOL) (formula: C₃H₈O₃).



Mol	Chain	Residues	Atoms			ZeroOcc	AltConf
4	A	1	Total	C	O	0	0
			6	3	3		
4	B	1	Total	C	O	0	1
			12	6	6		
4	B	1	Total	C	O	0	0
			6	3	3		

- Molecule 5 is water.

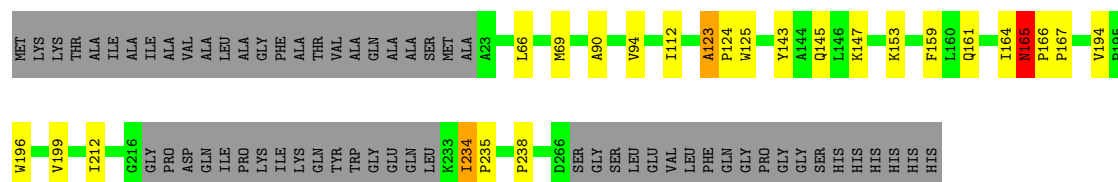
Mol	Chain	Residues	Atoms		ZeroOcc	AltConf
5	A	275	Total	O	0	0
			275	275		
5	B	280	Total	O	0	0
			280	280		

3 Residue-property plots [i](#)

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.

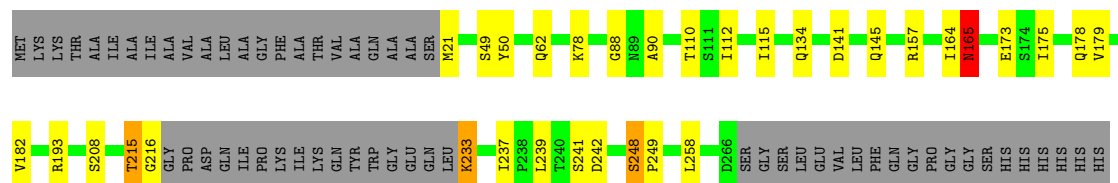
- Molecule 1: Vitamin B12-binding protein

Chain A: 



- Molecule 1: Vitamin B12-binding protein

Chain B: 



4 Data and refinement statistics

Property	Value	Source
Space group	C 1 2 1	Depositor
Cell constants a, b, c, α , β , γ	136.28Å 90.46Å 50.81Å 90.00° 110.74° 90.00°	Depositor
Resolution (Å)	19.67 – 1.50 19.67 – 1.50	Depositor EDS
% Data completeness (in resolution range)	96.8 (19.67-1.50) 96.8 (19.67-1.50)	Depositor EDS
R_{merge}	(Not available)	Depositor
R_{sym}	(Not available)	Depositor
$\langle I/\sigma(I) \rangle$ ¹	1.59 (at 1.50Å)	Xtriage
Refinement program	REFMAC 5.8.0071, PHENIX 1.10.1-2155	Depositor
R, R_{free}	0.196 , 0.229 0.196 , 0.228	Depositor DCC
R_{free} test set	4454 reflections (5.00%)	wwPDB-VP
Wilson B-factor (Å ²)	20.2	Xtriage
Anisotropy	0.262	Xtriage
Bulk solvent k_{sol} (e/Å ³), B_{sol} (Å ²)	0.37 , 42.9	EDS
L-test for twinning ²	$\langle L \rangle = 0.48$, $\langle L^2 \rangle = 0.31$	Xtriage
Estimated twinning fraction	0.068 for -h-2*k,l	Xtriage
F_o, F_c correlation	0.96	EDS
Total number of atoms	4266	wwPDB-VP
Average B, all atoms (Å ²)	25.0	wwPDB-VP

Xtriage's analysis on translational NCS is as follows: *The largest off-origin peak in the Patterson function is 8.52% 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

5.1 Standard geometry

Bond lengths and bond angles in the following residue types are not validated in this section: CBY, GOL, CYN

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	1.36	3/1798 (0.2%)	1.23	8/2450 (0.3%)
1	B	1.36	8/1822 (0.4%)	1.21	3/2481 (0.1%)
All	All	1.36	11/3620 (0.3%)	1.22	11/4931 (0.2%)

Chiral center outliers are detected by calculating the chiral volume of a chiral center and verifying if the center is modelled as a planar moiety or with the opposite hand. A planarity outlier is detected by checking planarity of atoms in a peptide group, atoms in a mainchain group or atoms of a sidechain that are expected to be planar.

Mol	Chain	#Chirality outliers	#Planarity outliers
1	A	0	1
1	B	0	1
All	All	0	2

All (11) bond length outliers are listed below:

Mol	Chain	Res	Type	Atoms	Z	Observed(Å)	Ideal(Å)
1	B	78	LYS	C-O	7.65	1.27	1.23
1	A	238	PRO	C-O	6.83	1.31	1.23
1	A	125	TRP	N-CA	-6.80	1.37	1.46
1	B	242	ASP	C-O	-6.57	1.16	1.24
1	B	178	GLN	N-CA	6.15	1.53	1.46
1	B	237	ILE	N-CA	5.86	1.50	1.46
1	B	215	THR	CA-C	5.85	1.59	1.52
1	B	179	VAL	N-CA	-5.69	1.39	1.46
1	B	248	SER	CA-C	5.54	1.59	1.52
1	B	78	LYS	N-CA	5.17	1.50	1.46
1	A	125	TRP	C-O	-5.11	1.17	1.24

All (11) bond angle outliers are listed below:

Mol	Chain	Res	Type	Atoms	Z	Observed(°)	Ideal(°)
1	B	165	ASN	CA-C-N	-9.79	110.30	120.38
1	B	165	ASN	C-N-CA	-9.79	110.30	120.38
1	A	165	ASN	CA-C-N	-7.00	113.17	120.38
1	A	165	ASN	C-N-CA	-7.00	113.17	120.38
1	A	153	LYS	N-CA-C	5.75	116.65	109.57
1	A	234	ILE	CA-C-N	5.57	125.89	119.93
1	A	234	ILE	C-N-CA	5.57	125.89	119.93
1	A	194	VAL	CA-C-O	5.54	122.79	119.19
1	B	258	LEU	N-CA-C	-5.09	105.82	111.36
1	A	123	ALA	CA-C-N	-5.08	114.59	119.87
1	A	123	ALA	C-N-CA	-5.08	114.59	119.87

There are no chirality outliers.

All (2) planarity outliers are listed below:

Mol	Chain	Res	Type	Group
1	A	165	ASN	Peptide
1	B	165	ASN	Peptide

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	1762	0	1787	15	0
1	B	1783	0	1814	21	0
2	A	4	0	0	8	0
2	B	2	0	0	0	0
3	A	68	0	72	15	0
3	B	68	0	72	5	0
4	A	6	0	8	0	0
4	B	18	0	24	7	0
5	A	275	0	0	2	1
5	B	280	0	0	5	0
All	All	4266	0	3777	54	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 7.

All (54) 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:B:90:ALA:HB1	5:B:621:HOH:O	1.47	1.13
2:A:301:CYN:C	3:A:302:CBY:N22	2.16	1.08
1:B:50:TYR:H	4:B:304:GOL:H2	1.21	1.04
1:B:62:GLN:HE22	4:B:304:GOL:H32	1.35	0.91
2:A:301:CYN:C	3:A:302:CBY:CO	1.49	0.89
2:A:301:CYN:C	3:A:302:CBY:N21	2.38	0.87
1:B:62:GLN:NE2	4:B:304:GOL:H32	2.00	0.76
1:A:143:TYR:OH	5:A:401:HOH:O	2.03	0.76
2:A:301:CYN:C	3:A:302:CBY:N23	2.52	0.73
1:B:215:THR:HB	1:B:241:SER:HA	1.72	0.71
1:A:212:ILE:HG13	1:A:234:ILE:HD11	1.73	0.71
3:A:302:CBY:H20B	2:A:303:CYN:C	2.24	0.67
1:B:193:ARG:NH2	5:B:407:HOH:O	2.31	0.64
3:B:301:CBY:C35	3:B:301:CBY:H36	2.29	0.63
1:B:208:SER:HB2	5:B:431:HOH:O	1.98	0.62
1:A:145:GLN:NE2	5:A:404:HOH:O	2.34	0.61
1:B:216:GLY:N	1:B:239:LEU:O	2.32	0.61
1:A:234:ILE:HD12	1:A:235:PRO:O	2.00	0.60
1:A:164:ILE:HD12	1:A:165:ASN:N	2.17	0.60
1:A:234:ILE:HD12	1:A:234:ILE:C	2.26	0.60
3:A:302:CBY:H35A	3:A:302:CBY:H36	1.84	0.60
3:A:302:CBY:H36	3:A:302:CBY:C35	2.32	0.59
1:A:123:ALA:HB3	1:A:124:PRO:HD3	1.86	0.58
3:B:301:CBY:H36	3:B:301:CBY:H35A	1.86	0.57
2:A:301:CYN:C	3:A:302:CBY:N24	2.68	0.57
1:B:62:GLN:HE22	4:B:304:GOL:C3	2.12	0.56
1:A:212:ILE:CG1	1:A:234:ILE:HD11	2.35	0.56
2:A:301:CYN:C	3:A:302:CBY:C6	2.85	0.55
3:B:301:CBY:O28	3:B:301:CBY:H3	2.06	0.55
1:B:157[B]:ARG:NH2	5:B:401:HOH:O	2.20	0.54
1:B:110:THR:HB	1:B:173:GLU:O	2.08	0.54
1:B:233:LYS:HE2	1:B:233:LYS:HA	1.97	0.47
1:B:164:ILE:O	1:B:165:ASN:C	2.58	0.47
1:B:62:GLN:OE1	4:B:304:GOL:C3	2.63	0.46
3:B:301:CBY:C35	3:B:301:CBY:C36	2.92	0.46
1:B:88:GLY:C	5:B:465:HOH:O	2.59	0.46
1:A:164:ILE:HD12	1:A:164:ILE:C	2.41	0.45
1:A:159:PHE:CE2	1:A:161:GLN:HB2	2.52	0.44
1:B:141:ASP:O	1:B:145:GLN:HG3	2.17	0.44
1:B:115:ILE:HD11	1:B:175:ILE:CD1	2.47	0.44
1:B:62:GLN:CD	4:B:304:GOL:H32	2.42	0.44

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Atom-1	Atom-2	Interatomic distance (Å)	Clash overlap (Å)
1:B:49:SER:HA	4:B:304:GOL:H31	2.00	0.43
3:A:302:CBY:C35	3:A:302:CBY:C36	2.97	0.43
1:A:196:TRP:CG	3:A:302:CBY:H49A	2.53	0.42
1:A:66:LEU:HB2	3:A:302:CBY:N33	2.36	0.41
1:A:167:PRO:HG2	1:A:199:VAL:O	2.20	0.41
3:B:301:CBY:H35A	3:B:301:CBY:C36	2.50	0.41
2:A:301:CYN:C	3:A:302:CBY:C4	2.99	0.41
3:A:302:CBY:H35A	3:A:302:CBY:C36	2.51	0.41
1:B:215:THR:HB	1:B:241:SER:CA	2.44	0.41
1:A:69:MET:HE2	1:A:69:MET:HB3	1.86	0.40
1:B:248:SER:HB2	1:B:249:PRO:CD	2.51	0.40
1:A:69:MET:HE1	1:A:94:VAL:HG22	2.02	0.40
3:A:302:CBY:H30	3:A:302:CBY:H20	2.03	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:446:HOH:O	5:A:542:HOH:O[2_454]	2.02	0.18

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	224/289 (78%)	219 (98%)	3 (1%)	2 (1%)	14	3
1	B	227/289 (78%)	220 (97%)	6 (3%)	1 (0%)	30	12
All	All	451/578 (78%)	439 (97%)	9 (2%)	3 (1%)	18	5

All (3) Ramachandran outliers are listed below:

Mol	Chain	Res	Type
1	A	90	ALA
1	B	165	ASN
1	A	166	PRO

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	191/235 (81%)	189 (99%)	2 (1%)	68	45
1	B	193/235 (82%)	188 (97%)	5 (3%)	40	13
All	All	384/470 (82%)	377 (98%)	7 (2%)	51	24

All (7) residues with a non-rotameric sidechain are listed below:

Mol	Chain	Res	Type
1	A	112	ILE
1	A	147	LYS
1	B	21	MET
1	B	112	ILE
1	B	134	GLN
1	B	182	VAL
1	B	233	LYS

Sometimes sidechains can be flipped to improve hydrogen bonding and reduce clashes. All (6) such sidechains are listed below:

Mol	Chain	Res	Type
1	A	128	GLN
1	A	134	GLN
1	A	142	GLN
1	A	260	ASN
1	B	96	GLN
1	B	142	GLN

5.3.3 RNA ⓘ

There are no RNA molecules in this entry.

5.4 Non-standard residues in protein, DNA, RNA chains ⓘ

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

5.5 Carbohydrates ⓘ

There are no oligosaccharides in this entry.

5.6 Ligand geometry ⓘ

9 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	$\# Z > 2$
2	CYN	B	302	-	0,1,1	-	-	-		
4	GOL	A	304	-	5,5,5	0.35	0	5,5,5	0.84	0
2	CYN	A	301	3	0,1,1	-	-	-		
4	GOL	B	303[B]	-	5,5,5	0.31	0	5,5,5	0.19	0
4	GOL	B	304	-	5,5,5	0.73	0	5,5,5	1.31	1 (20%)
3	CBY	A	302	2	65,75,75	1.23	5 (7%)	106,125,125	1.70	25 (23%)
2	CYN	A	303	-	0,1,1	-	-	-		
3	CBY	B	301	-	65,75,75	1.11	3 (4%)	106,125,125	1.56	17 (16%)
4	GOL	B	303[A]	-	5,5,5	0.37	0	5,5,5	0.75	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
4	GOL	A	304	-	-	0/4/4/4	-

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Mol	Type	Chain	Res	Link	Chirals	Torsions	Rings
4	GOL	B	303[B]	-	-	2/4/4/4	-
4	GOL	B	304	-	-	4/4/4/4	-
3	CBY	A	302	2	-	5/40/191/191	-
3	CBY	B	301	-	-	5/40/191/191	-
4	GOL	B	303[A]	-	-	2/4/4/4	-

All (8) bond length outliers are listed below:

Mol	Chain	Res	Type	Atoms	Z	Observed(Å)	Ideal(Å)
3	A	302	CBY	C14-N23	5.14	1.44	1.30
3	B	301	CBY	C14-N23	4.39	1.42	1.30
3	B	301	CBY	C48-C13	-3.30	1.46	1.54
3	A	302	CBY	C55-C17	-2.99	1.47	1.54
3	B	301	CBY	C36-C7	-2.66	1.50	1.54
3	A	302	CBY	C10-C11	-2.48	1.30	1.37
3	A	302	CBY	C47-C12	-2.09	1.49	1.54
3	A	302	CBY	C19-N24	2.05	1.53	1.49

All (43) bond angle outliers are listed below:

Mol	Chain	Res	Type	Atoms	Z	Observed(°)	Ideal(°)
3	B	301	CBY	C20-C1-N21	-5.43	101.35	110.27
3	B	301	CBY	C19-C1-N21	4.48	107.37	101.67
3	A	302	CBY	C20-C1-N21	-4.43	103.00	110.27
3	A	302	CBY	C11-N23-C14	-4.20	104.72	106.31
3	A	302	CBY	C10-C9-N22	-3.90	121.26	125.73
3	A	302	CBY	C7-C6-C5	-3.79	122.10	128.07
3	B	301	CBY	C17-C16-N24	-3.65	104.74	110.87
3	B	301	CBY	C17-C16-C15	3.60	132.20	126.73
3	B	301	CBY	C7-C6-C5	-3.48	122.59	128.07
3	A	302	CBY	O58-C57-N59	3.37	129.37	123.01
3	A	302	CBY	C17-C16-C15	3.36	131.84	126.73
3	B	301	CBY	C18-C17-C16	3.33	105.67	100.33
3	A	302	CBY	C56-C57-N59	-3.31	110.84	116.42
3	A	302	CBY	C2-C3-C4	-3.23	97.96	101.63
3	A	302	CBY	C5-C4-N21	-3.18	119.03	124.19
3	A	302	CBY	C1-C2-C3	3.12	105.59	101.60
3	B	301	CBY	C12-C13-C14	-3.11	97.75	101.86
3	A	302	CBY	C15-C14-N23	-3.09	120.56	126.68
3	A	302	CBY	C12-C13-C14	-2.99	97.91	101.86
3	B	301	CBY	C5-C6-N22	2.95	128.38	123.88

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Mol	Chain	Res	Type	Atoms	Z	Observed(°)	Ideal(°)
3	B	301	CBY	C12-C11-N23	-2.83	108.41	111.48
3	A	302	CBY	C17-C16-N24	-2.80	106.16	110.87
3	B	301	CBY	C5-C4-N21	-2.79	119.65	124.19
3	A	302	CBY	C19-C1-N21	2.78	105.20	101.67
3	B	301	CBY	C47-C12-C46	2.67	113.87	109.35
4	B	304	GOL	O3-C3-C2	2.67	122.98	110.20
3	A	302	CBY	C47-C12-C46	2.66	113.84	109.35
3	A	302	CBY	C48-C49-C50	-2.61	103.72	112.59
3	A	302	CBY	C5-C6-N22	2.54	127.75	123.88
3	A	302	CBY	C2-C1-C19	2.48	122.98	118.72
3	A	302	CBY	C7-C8-C9	2.47	104.07	100.90
3	B	301	CBY	O58-C57-N59	2.44	127.62	123.01
3	A	302	CBY	C48-C13-C14	-2.41	104.01	109.63
3	A	302	CBY	C13-C14-N23	2.40	114.55	109.39
3	A	302	CBY	C54-C17-C18	-2.34	109.53	112.98
3	A	302	CBY	C7-C37-C38	2.33	121.26	114.25
3	B	301	CBY	C48-C49-C50	-2.28	104.86	112.59
3	B	301	CBY	C56-C57-N59	-2.17	112.77	116.42
3	B	301	CBY	C25-C2-C1	2.13	117.00	113.78
3	A	302	CBY	C8-C9-C10	2.13	127.92	123.32
3	A	302	CBY	C12-C11-N23	-2.12	109.19	111.48
3	B	301	CBY	C55-C17-C18	-2.10	107.08	111.15
3	B	301	CBY	C26-C2-C3	-2.01	103.86	107.41

There are no chirality outliers.

All (18) torsion outliers are listed below:

Mol	Chain	Res	Type	Atoms
3	A	302	CBY	N59-C71-C72-C73
3	A	302	CBY	N59-C71-C72-O8
3	B	301	CBY	N59-C71-C72-O8
4	B	304	GOL	O1-C1-C2-C3
4	B	303[A]	GOL	C1-C2-C3-O3
4	B	303[B]	GOL	C1-C2-C3-O3
4	B	304	GOL	C1-C2-C3-O3
4	B	304	GOL	O1-C1-C2-O2
4	B	303[A]	GOL	O2-C2-C3-O3
3	B	301	CBY	C30-C31-C32-O34
3	B	301	CBY	N59-C71-C72-C73
3	A	302	CBY	C30-C31-C32-N33
3	A	302	CBY	C30-C31-C32-O34
3	A	302	CBY	C14-C13-C48-C49

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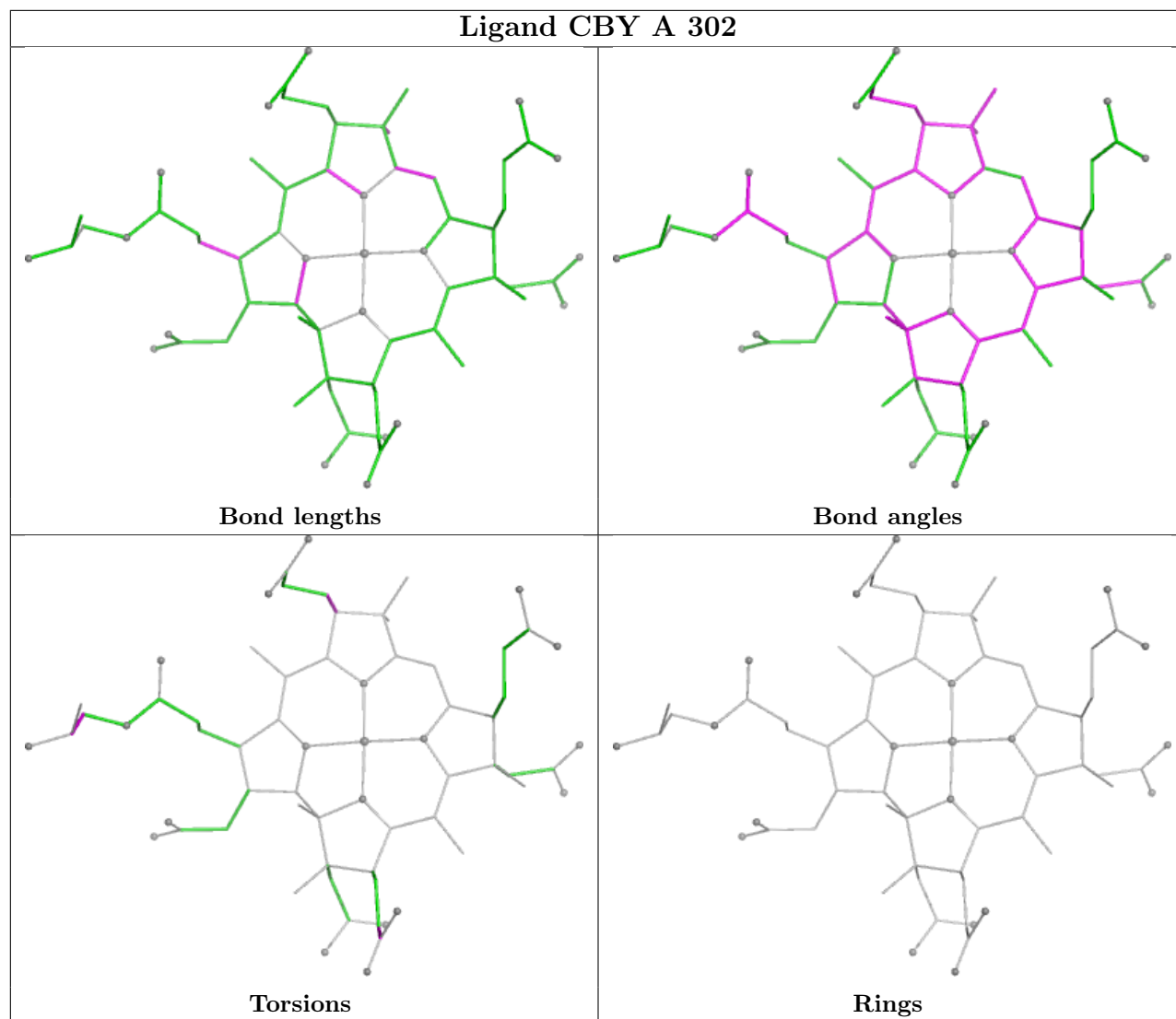
Mol	Chain	Res	Type	Atoms
3	B	301	CBY	C30-C31-C32-N33
4	B	304	GOL	O2-C2-C3-O3
4	B	303[B]	GOL	O2-C2-C3-O3
3	B	301	CBY	C55-C56-C57-O58

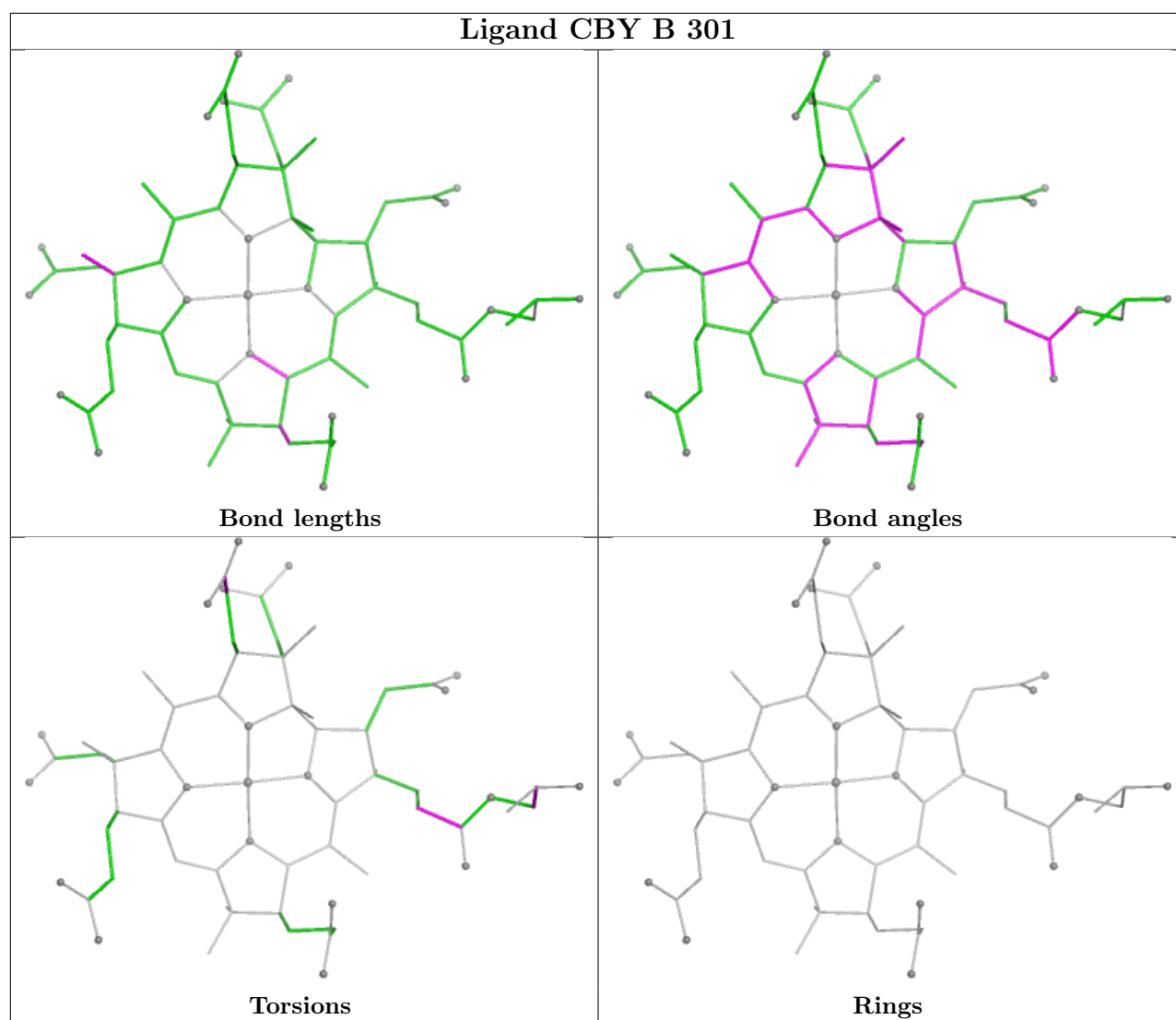
There are no ring outliers.

5 monomers are involved in 27 short contacts:

Mol	Chain	Res	Type	Clashes	Symm-Clashes
2	A	301	CYN	7	0
4	B	304	GOL	7	0
3	A	302	CBY	15	0
2	A	303	CYN	1	0
3	B	301	CBY	5	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 [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, 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	228/289 (78%)	-1.10	0 100 100	12, 20, 44, 68	0
1	B	230/289 (79%)	-1.07	0 100 100	12, 22, 45, 71	1 (0%)
All	All	458/578 (79%)	-1.09	0 100 100	12, 21, 45, 71	1 (0%)

There are no RSRZ outliers to report.

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(Å ²)	Q<0.9
2	CYN	A	301	2/2	0.99	0.07	23,23,23,25	2
2	CYN	A	303	2/2	0.99	0.05	23,23,23,25	0
2	CYN	B	302	2/2	0.99	0.09	26,26,26,31	0
3	CBY	A	302	68/68	0.99	0.04	13,19,46,57	0
3	CBY	B	301	68/68	0.99	0.04	16,22,53,85	0
4	GOL	A	304	6/6	0.99	0.04	40,42,43,51	0
4	GOL	B	303[A]	6/6	0.99	0.04	27,34,37,39	6

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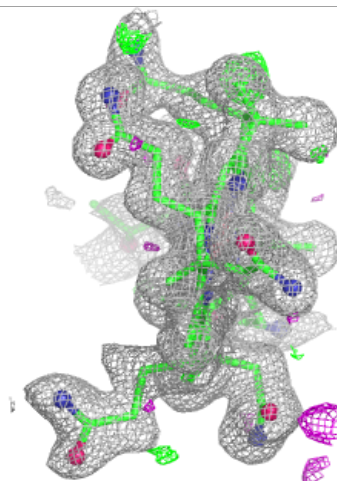
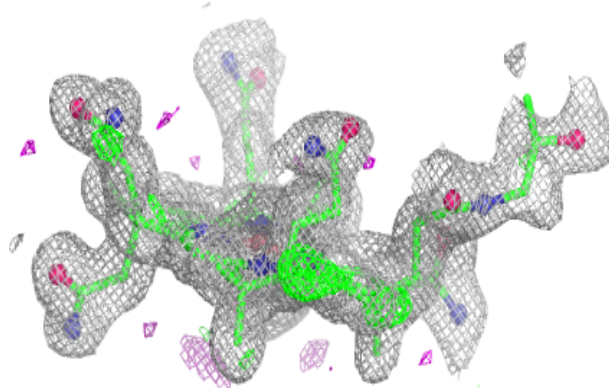
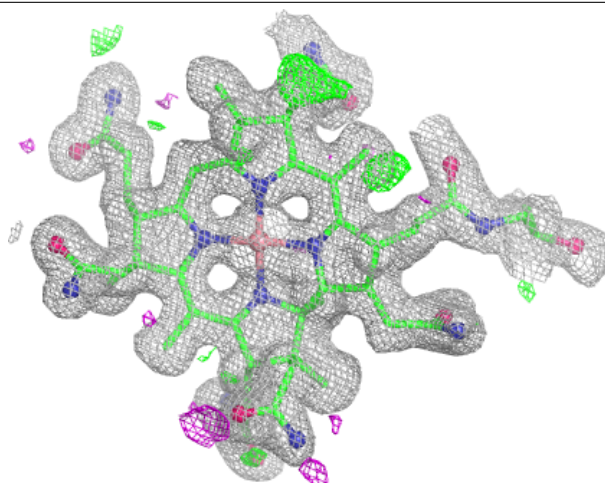
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Mol	Type	Chain	Res	Atoms	RSCC	RSR	B-factors($\text{\AA}^2$)	Q<0.9
4	GOL	B	303[B]	6/6	0.99	0.04	51,62,67,69	6
4	GOL	B	304	6/6	0.99	0.04	23,35,37,41	0

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.

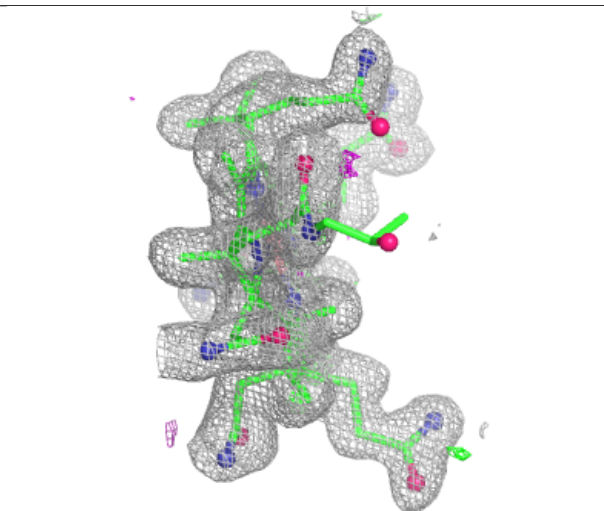
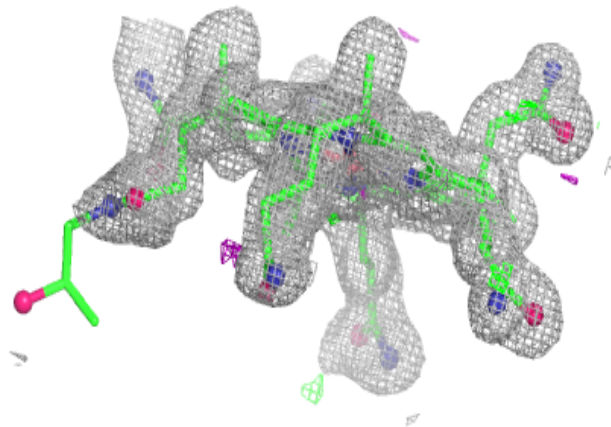
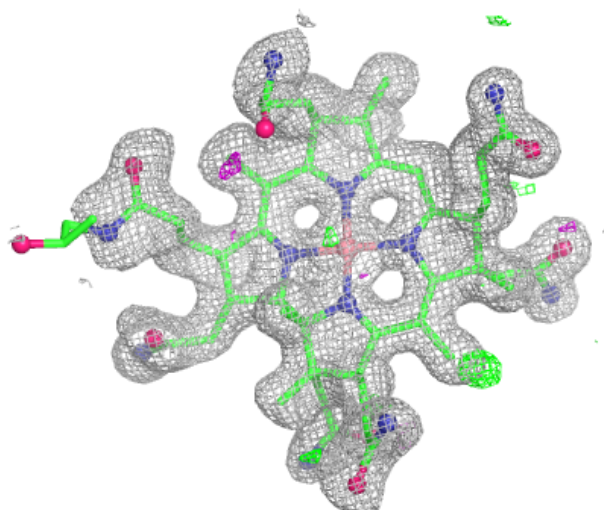
Electron density around CBY A 302:

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 CBY B 301:

$2mF_o-DF_c$ (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.