Full wwPDB X-ray Structure Validation Report ⓘ

Aug 14, 2023 – 12:47 PM EDT

PDB ID	:	8DYJ
Title	:	Crystal structure of human methylmalonyl-CoA mutase in complex with ADP and cob(II)alamin
Authors	:	Mascarenhas, R.N.; Gouda, H.; Banerjee, R.
Deposited on	:	2022-08-04
Resolution	:	2.20 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:

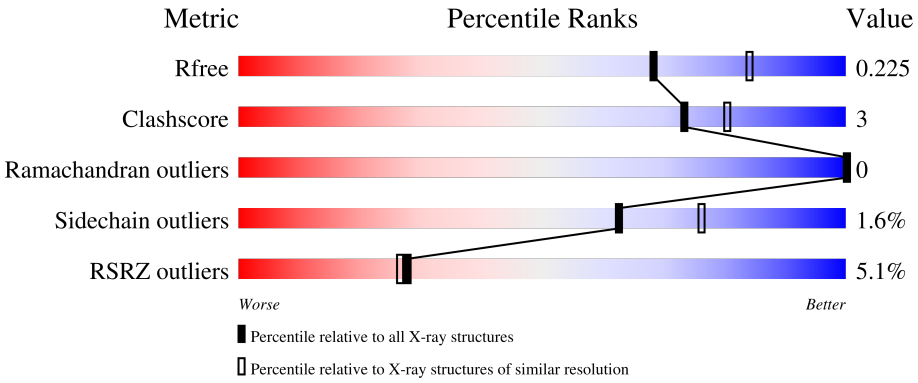
MolProbity	:	4.02b-467
Mogul	:	1.8.5 (274361), CSD as541be (2020)
Xtriage (Phenix)	:	1.13
EDS	:	2.35
buster-report	:	1.1.7 (2018)
Percentile statistics	:	20191225.v01 (using entries in the PDB archive December 25th 2019)
Refmac	:	5.8.0158
CCP4	:	7.0.044 (Gargrove)
Ideal geometry (proteins)	:	Engh & Huber (2001)
Ideal geometry (DNA, RNA)	:	Parkinson et al. (1996)
Validation Pipeline (wwPDB-VP)	:	2.35

1 Overall quality at a glance (i)

The following experimental techniques were used to determine the structure:
X-RAY DIFFRACTION

The reported resolution of this entry is 2.20 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}	130704	4898 (2.20-2.20)
Clashscore	141614	5594 (2.20-2.20)
Ramachandran outliers	138981	5503 (2.20-2.20)
Sidechain outliers	138945	5504 (2.20-2.20)
RSRZ outliers	127900	4800 (2.20-2.20)

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 <=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	B	762	5% 85% 8% 7%

2 Entry composition (i)

There are 4 unique types of molecules in this entry. The entry contains 5664 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 Methylmalonyl-CoA mutase, mitochondrial.

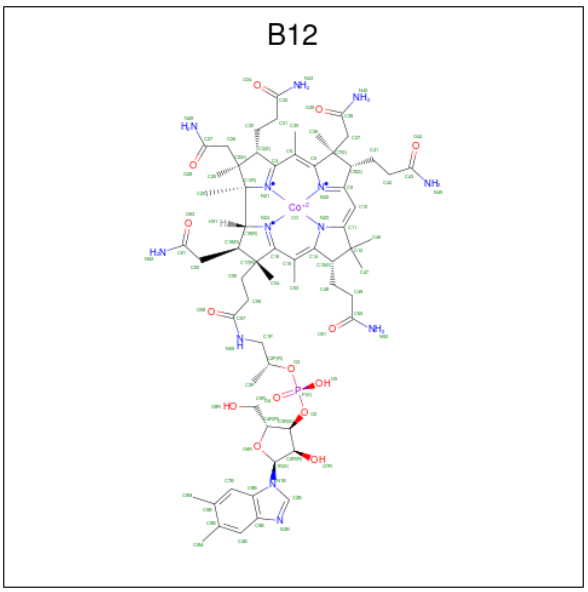
Mol	Chain	Residues	Atoms					ZeroOcc	AltConf	Trace
			Total	C	N	O	S			
1	B	708	5425	3434	936	1025	30	0	2	0

There are 25 discrepancies between the modelled and reference sequences:

Chain	Residue	Modelled	Actual	Comment	Reference
B	-26	MET	-	initiating methionine	UNP P22033
B	462	THR	ALA	conflict	UNP P22033
B	634	VAL	ILE	conflict	UNP P22033
B	714	ALA	-	expression tag	UNP P22033
B	715	GLU	-	expression tag	UNP P22033
B	716	ASN	-	expression tag	UNP P22033
B	717	LEU	-	expression tag	UNP P22033
B	718	TYR	-	expression tag	UNP P22033
B	719	PHE	-	expression tag	UNP P22033
B	720	GLN	-	expression tag	UNP P22033
B	721	SER	-	expression tag	UNP P22033
B	722	HIS	-	expression tag	UNP P22033
B	723	HIS	-	expression tag	UNP P22033
B	724	HIS	-	expression tag	UNP P22033
B	725	HIS	-	expression tag	UNP P22033
B	726	HIS	-	expression tag	UNP P22033
B	727	HIS	-	expression tag	UNP P22033
B	728	ASP	-	expression tag	UNP P22033
B	729	TYR	-	expression tag	UNP P22033
B	730	LYS	-	expression tag	UNP P22033
B	731	ASP	-	expression tag	UNP P22033
B	732	ASP	-	expression tag	UNP P22033
B	733	ASP	-	expression tag	UNP P22033
B	734	ASP	-	expression tag	UNP P22033
B	735	LYS	-	expression tag	UNP P22033

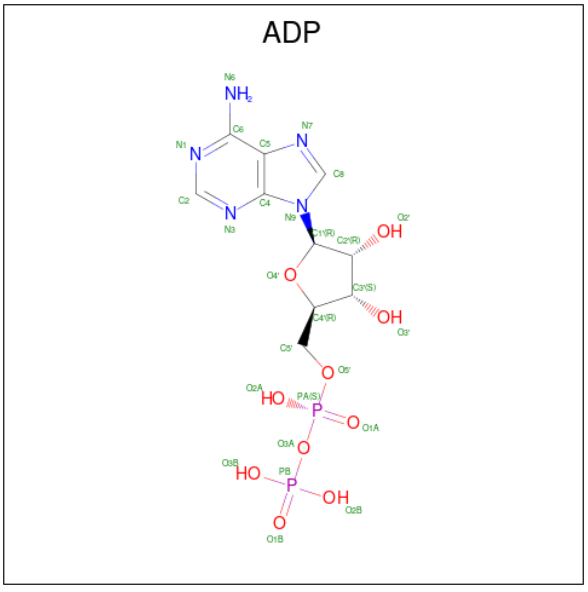
- Molecule 2 is COBALAMIN (three-letter code: B12) (formula: $C_{62}H_{89}CoN_{13}O_{14}P$) (labeled

as "Ligand of Interest" by depositor).



Mol	Chain	Residues	Atoms						ZeroOcc	AltConf
2	B	1	Total	C	Co	N	O	P	0	0
			91	62	1	13	14	1		

- Molecule 3 is ADENOSINE-5'-DIPHOSPHATE (three-letter code: ADP) (formula: $C_{10}H_{15}N_5O_{10}P_2$) (labeled as "Ligand of Interest" by depositor).



Mol	Chain	Residues	Atoms					ZeroOcc	AltConf
3	B	1	Total	C	N	O	P	0	0
			27	10	5	10	2		

- Molecule 4 is water.

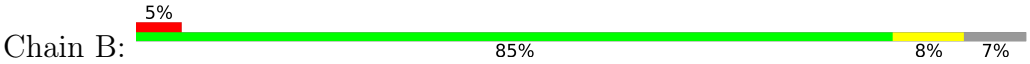
Mol	Chain	Residues	Atoms	ZeroOcc	AltConf
4	B	121	Total O 121 121	0	0

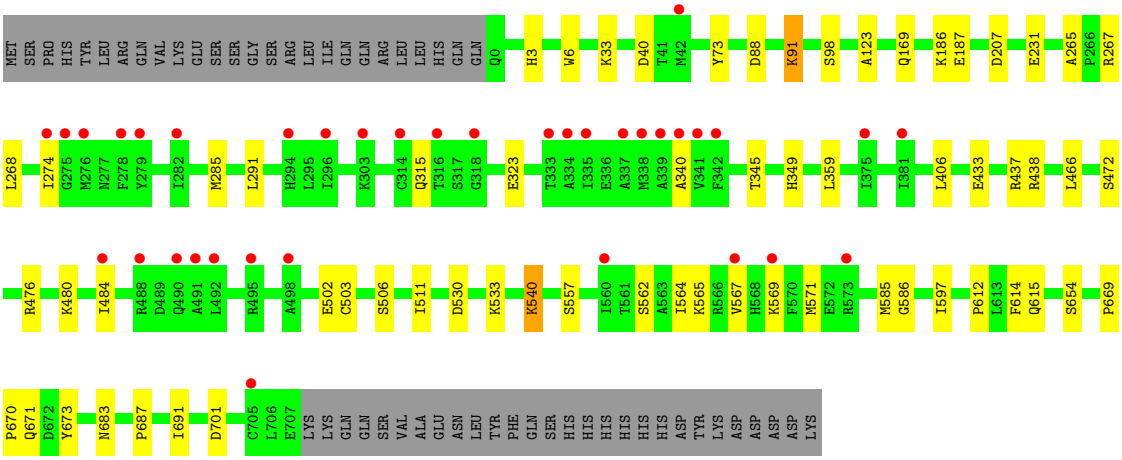
3 Residue-property plots (i)

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: Methylmalonyl-CoA mutase, mitochondrial

Chain B:





4 Data and refinement statistics (i)

Property	Value	Source
Space group	C 2 2 21	Depositor
Cell constants a, b, c, α, β, γ	61.02Å 129.36Å 188.42Å 90.00° 90.00° 90.00°	Depositor
Resolution (Å)	47.10 – 2.20 47.11 – 2.20	Depositor EDS
% Data completeness (in resolution range)	99.0 (47.10-2.20) 99.0 (47.11-2.20)	Depositor EDS
R_{merge}	(Not available)	Depositor
R_{sym}	(Not available)	Depositor
$< I/\sigma(I) >$ [1]	2.62 (at 2.20Å)	Xtriage
Refinement program	PHENIX 1.15.2_3472	Depositor
R, R_{free}	0.195 , 0.225 0.195 , 0.225	Depositor DCC
R_{free} test set	1904 reflections (5.02%)	wwPDB-VP
Wilson B-factor (Å^2)	50.6	Xtriage
Anisotropy	0.554	Xtriage
Bulk solvent k_{sol}(e/Å^3), B_{sol}(Å^2)	0.36 , 54.7	EDS
L-test for twinning[2]	$< \|L\| > = 0.50$, $< L^2 > = 0.34$	Xtriage
Estimated twinning fraction	No twinning to report.	Xtriage
F_o,F_c correlation	0.96	EDS
Total number of atoms	5664	wwPDB-VP
Average B, all atoms (Å^2)	65.0	wwPDB-VP

Xtriage's analysis on translational NCS is as follows: *The largest off-origin peak in the Patterson function is 5.30% of the height of the origin peak. No significant pseudotranslation is detected.*

[1] Intensities estimated from amplitudes.

[2] Theoretical values of $< |L| >$, $< L^2 >$ 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: ADP, B12

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	B	0.27	0/5537	0.42	0/7501

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

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	B	5425	0	5373	32	0
2	B	91	0	88	6	0
3	B	27	0	12	2	0
4	B	121	0	0	1	0
All	All	5664	0	5473	36	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 3.

All (36) 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:231:GLU:HB3	2:B:801:B12:H532	1.63	0.78
1:B:91:LYS:NZ	4:B:901:HOH:O	2.22	0.61
1:B:503:CYS:HA	1:B:506:SER:HB3	1.81	0.61
1:B:123:ALA:HB1	2:B:801:B12:H362	1.82	0.61
1:B:683:ASN:ND2	1:B:701:ASP:OD2	2.33	0.61
1:B:88:ASP:HA	1:B:91:LYS:HE3	1.83	0.60
1:B:73:TYR:HA	1:B:98:SER:HB3	1.86	0.58
2:B:801:B12:H552	2:B:801:B12:H531	1.86	0.57
1:B:433:GLU:O	1:B:437:ARG:HG3	2.04	0.57
1:B:472:SER:O	1:B:476:ARG:HG3	2.05	0.56
1:B:291:LEU:HD21	1:B:406:LEU:HB2	1.89	0.54
2:B:801:B12:H8	3:B:802:ADP:O1A	2.08	0.54
1:B:265:ALA:HA	1:B:268:LEU:HG	1.91	0.53
1:B:186:LYS:NZ	1:B:187:GLU:OE2	2.41	0.53
1:B:359:LEU:HB2	1:B:466:LEU:HD23	1.93	0.50
2:B:801:B12:H371	3:B:802:ADP:O1A	2.12	0.50
1:B:597:ILE:HD13	1:B:691:ILE:HD13	1.94	0.48
1:B:267:ARG:HD3	1:B:267:ARG:HA	1.67	0.48
1:B:502:GLU:O	1:B:506:SER:N	2.36	0.48
1:B:3:HIS:HB3	1:B:6:TRP:HB3	1.94	0.48
1:B:480:LYS:O	1:B:484:ILE:HG13	2.14	0.47
1:B:315:GLN:HG3	1:B:349:HIS:HD2	1.79	0.46
1:B:323:GLU:OE1	1:B:687:PRO:HD2	2.16	0.46
1:B:530:ASP:HA	1:B:533:LYS:HB2	1.98	0.46
1:B:564:ILE:O	1:B:567:VAL:HG12	2.16	0.46
1:B:207:ASP:OD2	1:B:511:ILE:HG13	2.17	0.44
2:B:801:B12:C61	2:B:801:B12:H551	2.48	0.43
1:B:33:LYS:NZ	1:B:40:ASP:OD1	2.43	0.43
1:B:586:GLY:O	1:B:614:PHE:HA	2.19	0.42
1:B:274:ILE:HG13	1:B:340:ALA:HB2	2.00	0.41
1:B:565:LYS:O	1:B:569:LYS:HG3	2.20	0.41
1:B:612:PRO:HD2	1:B:615:GLN:NE2	2.36	0.41
1:B:670:PRO:HA	1:B:673:TYR:CD1	2.56	0.41
1:B:285:MET:HE1	1:B:345:THR:HB	2.03	0.41
1:B:669:PRO:HB2	1:B:671:GLN:HG2	2.02	0.40
1:B:540:LYS:HB2	1:B:540:LYS:HE2	1.59	0.40

There are no symmetry-related clashes.

5.3 Torsion angles (i)

5.3.1 Protein backbone (i)

In the following table, the Percentiles column shows the percent Ramachandran outliers of the chain as a percentile score with respect to all X-ray entries followed by that with respect to entries of similar resolution.

The Analysed column shows the number of residues for which the backbone conformation was analysed, and the total number of residues.

Mol	Chain	Analysed	Favoured	Allowed	Outliers	Percentiles
1	B	708/762 (93%)	693 (98%)	15 (2%)	0	100 100

There are no Ramachandran outliers to report.

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	B	565/636 (89%)	556 (98%)	9 (2%)	62 76

All (9) residues with a non-rotameric sidechain are listed below:

Mol	Chain	Res	Type
1	B	91	LYS
1	B	169	GLN
1	B	438	ARG
1	B	540	LYS
1	B	557	SER
1	B	562	SER
1	B	571	MET
1	B	585	MET
1	B	654	SER

Sometimes sidechains can be flipped to improve hydrogen bonding and reduce clashes. All (1) such sidechains are listed below:

Mol	Chain	Res	Type
1	B	106	HIS

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 monosaccharides in this entry.

5.6 Ligand geometry

2 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	B12	B	801	1	90,101,101	1.03	3 (3%)	137,166,166	1.62	22 (16%)
3	ADP	B	802	-	24,29,29	1.74	2 (8%)	29,45,45	2.00	7 (24%)

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	B12	B	801	1	-	9/52/223/223	0/3/11/11
3	ADP	B	802	-	-	3/12/32/32	0/3/3/3

All (5) bond length outliers are listed below:

Mol	Chain	Res	Type	Atoms	Z	Observed(Å)	Ideal(Å)
3	B	802	ADP	PA-O5'	6.38	1.85	1.59
2	B	801	B12	C35-C5	2.78	1.56	1.50
2	B	801	B12	C14-N23	2.70	1.38	1.35
2	B	801	B12	C54-C17	2.59	1.59	1.54
3	B	802	ADP	O5'-C5'	-2.13	1.36	1.44

All (29) bond angle outliers are listed below:

Mol	Chain	Res	Type	Atoms	Z	Observed(^{o})	Ideal(^{o})
3	B	802	ADP	PA-O3A-PB	-6.65	109.99	132.83
2	B	801	B12	C7B-C8B-C9B	5.18	125.67	120.54
2	B	801	B12	C18-C17-C16	4.43	106.05	100.67
2	B	801	B12	C16-C15-C14	-4.40	114.58	121.25
2	B	801	B12	C55-C17-C16	3.99	124.53	116.65
2	B	801	B12	C53-C15-C16	3.93	127.14	120.38
2	B	801	B12	C54-C17-C16	-3.78	92.76	112.40
3	B	802	ADP	O2A-PA-O5'	-3.75	90.31	107.75
2	B	801	B12	C54-C17-C18	-3.67	107.56	112.98
2	B	801	B12	C2P-C1P-N59	-3.59	107.63	112.93
2	B	801	B12	C1P-N59-C57	-3.53	115.00	122.69
2	B	801	B12	C15-C16-N24	3.43	127.37	122.42
2	B	801	B12	C5B-C4B-C9B	-3.20	116.68	121.22
2	B	801	B12	C55-C56-C57	-3.16	104.33	111.23
2	B	801	B12	C17-C16-N24	-3.05	106.44	111.15
3	B	802	ADP	O5'-PA-O1A	-3.01	97.30	109.07
3	B	802	ADP	O2B-PB-O1B	2.98	122.34	110.68
2	B	801	B12	O6R-C1R-C2R	-2.84	102.77	106.93
2	B	801	B12	C5M-C5B-C6B	-2.76	115.08	120.74
2	B	801	B12	C1-C19-C18	-2.53	117.73	121.88
2	B	801	B12	C13-C14-C15	-2.46	120.56	124.32
3	B	802	ADP	PA-O5'-C5'	-2.44	107.38	121.68
2	B	801	B12	C18-C19-N24	2.41	105.98	102.31
2	B	801	B12	O28-C27-N29	-2.36	116.05	122.50
2	B	801	B12	C2-C1-C19	-2.30	114.96	118.60
2	B	801	B12	C4B-C5B-C6B	2.26	123.72	119.91
2	B	801	B12	C37-C7-C8	-2.04	102.92	108.39
3	B	802	ADP	C1'-N9-C4	-2.04	123.06	126.64
3	B	802	ADP	C2-N1-C6	-2.03	115.28	118.75

There are no chirality outliers.

All (12) torsion outliers are listed below:

Mol	Chain	Res	Type	Atoms
2	B	801	B12	C38-C37-C7-C36
2	B	801	B12	C42-C41-C8-C9
3	B	802	ADP	C3'-C4'-C5'-O5'
2	B	801	B12	C38-C37-C7-C8
3	B	802	ADP	O4'-C4'-C5'-O5'
3	B	802	ADP	PB-O3A-PA-O2A
2	B	801	B12	C2P-O3-P-O2
2	B	801	B12	C38-C37-C7-C6
2	B	801	B12	C30-C31-C32-N33
2	B	801	B12	C4-C3-C30-C31
2	B	801	B12	C30-C31-C32-O34
2	B	801	B12	C55-C56-C57-O58

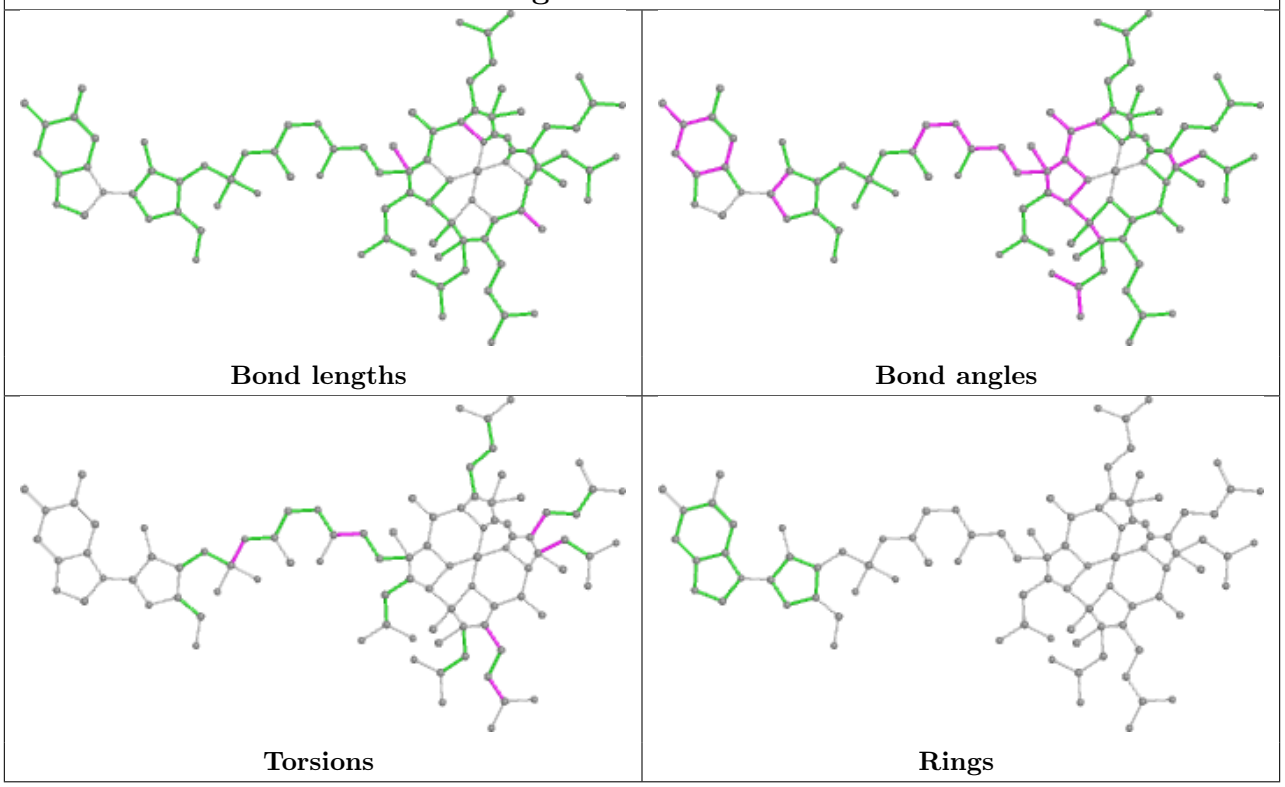
There are no ring outliers.

2 monomers are involved in 6 short contacts:

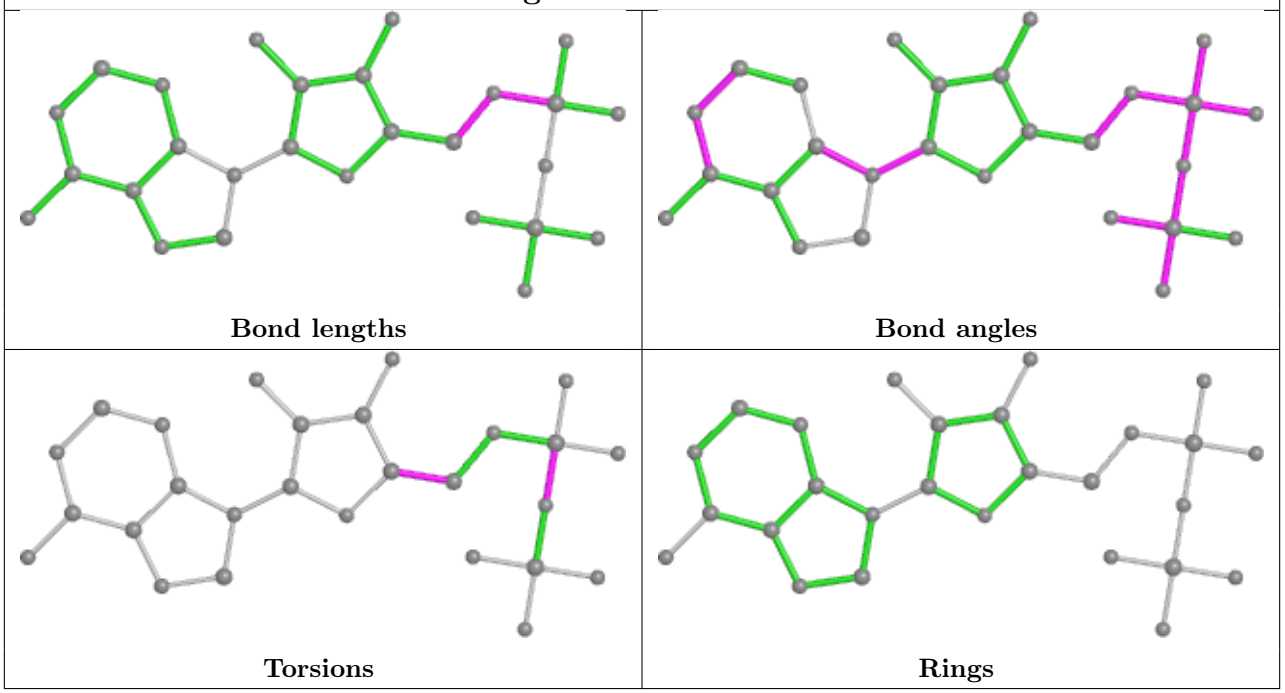
Mol	Chain	Res	Type	Clashes	Symm-Clashes
2	B	801	B12	6	0
3	B	802	ADP	2	0

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 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 B12 B 801



Ligand ADP B 802



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, 95^{th} 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	B	708/762 (92%)	0.21	36 (5%) 28 26	41, 64, 92, 117	0

All (36) RSRZ outliers are listed below:

Mol	Chain	Res	Type	RSRZ
1	B	492	LEU	4.4
1	B	495	ARG	4.3
1	B	491	ALA	3.9
1	B	339	ALA	3.7
1	B	335	ILE	3.6
1	B	334	ALA	3.6
1	B	341	VAL	3.6
1	B	338[A]	MET	3.3
1	B	342	PHE	3.2
1	B	296	ILE	3.2
1	B	314	CYS	3.1
1	B	278	PHE	3.1
1	B	488	ARG	3.1
1	B	333	THR	3.0
1	B	381	ILE	3.0
1	B	42	MET	2.9
1	B	340	ALA	2.9
1	B	337	ALA	2.9
1	B	375	ILE	2.9
1	B	316	THR	2.8
1	B	282	ILE	2.8
1	B	490	GLN	2.8
1	B	498	ALA	2.8
1	B	303	LYS	2.4
1	B	484	ILE	2.4
1	B	294	HIS	2.3
1	B	279	TYR	2.3

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Mol	Chain	Res	Type	RSRZ
1	B	318	GLY	2.3
1	B	569	LYS	2.3
1	B	276	MET	2.3
1	B	567	VAL	2.2
1	B	573	ARG	2.2
1	B	274	ILE	2.2
1	B	275	GLY	2.2
1	B	560	ILE	2.1
1	B	705	CYS	2.1

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 monosaccharides in this entry.

6.4 Ligands (i)

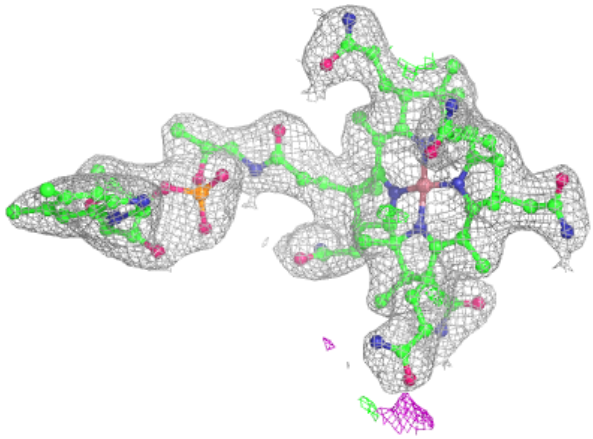
In the following table, the Atoms column lists the number of modelled atoms in the group and the number defined in the chemical component dictionary. The B-factors column lists the minimum, median, 95^{th} percentile and maximum values of B factors of atoms in the group. The column labelled 'Q< 0.9'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

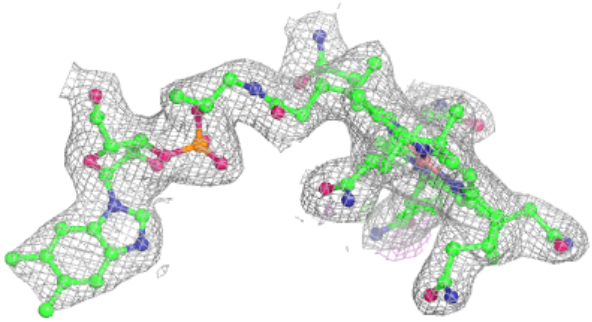
Mol	Type	Chain	Res	Atoms	RSCC	RSR	B-factors(Å^2)	Q<0.9
2	B12	B	801	91/91	0.96	0.17	40,48,57,59	0
3	ADP	B	802	27/27	0.96	0.14	56,62,65,68	0

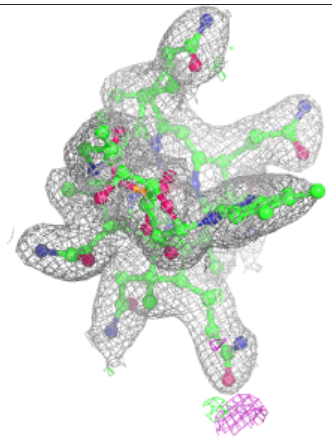
The following is a graphical depiction of the model fit to experimental electron density of all instances of the Ligand of Interest. In addition, ligands with molecular weight > 250 and outliers as shown on the geometry validation Tables will also be included. Each fit is shown from different orientation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

Electron density around B12 B 801:

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

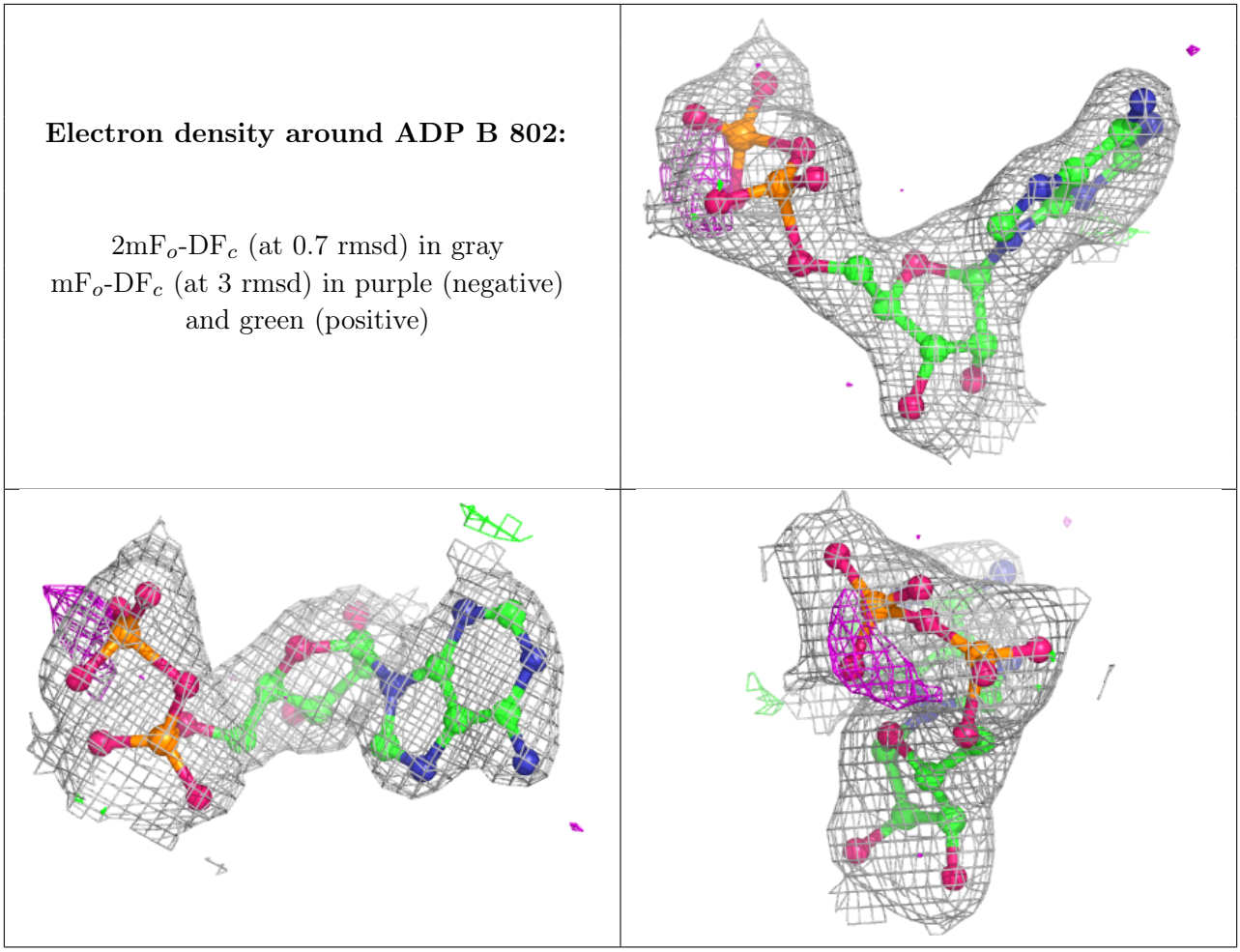






Electron density around ADP B 802:

$2mF_o$-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.