



# wwPDB X-ray Structure Validation Summary Report ⓘ

Feb 1, 2016 – 06:33 AM GMT

PDB ID : 2XIQ  
Title : Crystal structure of human methylmalonyl-CoA mutase in complex with adenosylcobalamin and malonyl-CoA  
Authors : Yue, W.W.; Froese, D.S.; Kochan, G.; Chaikuad, A.; Krojer, T.; Muniz, J.; Ugochukwu, E.; Arrowsmith, C.; Weigelt, J.; Edwards, A.; Bountra, C.; Oppermann, U.  
Deposited on : 2010-06-30  
Resolution : 1.95 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  
<http://wwpdb.org/validation/2016/XrayValidationReportHelp>  
with specific help available everywhere you see the ⓘ symbol.

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

MolProbity : 4.02b-467  
Mogul : 1.7 (RC4), CSD as536be (2015)  
Xtriage (Phenix) : 1.9-1692  
EDS : rb-20026688  
Percentile statistics : 20151230.v01 (using entries in the PDB archive December 30th 2015)  
Refmac : 5.8.0135  
CCP4 : 6.5.0  
Ideal geometry (proteins) : Engh & Huber (2001)  
Ideal geometry (DNA, RNA) : Parkinson et al. (1996)  
Validation Pipeline (wwPDB-VP) : trunk26865

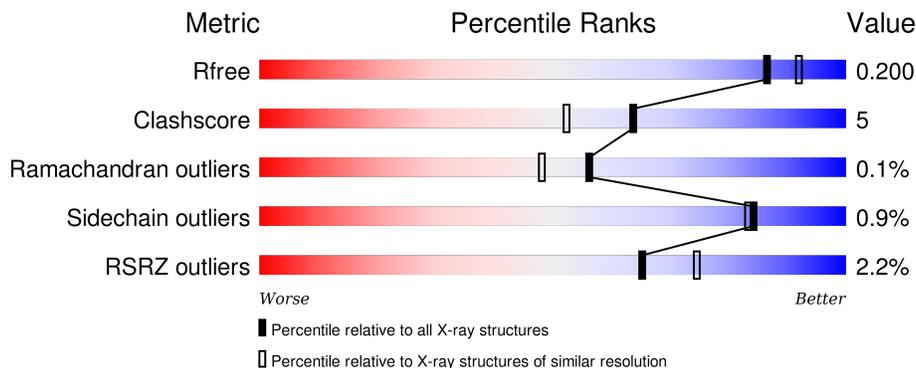
# 1 Overall quality at a glance

The following experimental techniques were used to determine the structure:

*X-RAY DIFFRACTION*

The reported resolution of this entry is 1.95 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))
$R_{free}$	91344	1833 (1.96-1.96)
Clashscore	102246	1953 (1.96-1.96)
Ramachandran outliers	100387	1936 (1.96-1.96)
Sidechain outliers	100360	1936 (1.96-1.96)
RSRZ outliers	91569	1835 (1.96-1.96)

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 on the lower bar indicate the fraction of residues that contain outliers for  $\geq 3$ , 2, 1 and 0 types of geometric quality criteria. 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	762	 2% 86% 7% 6%
1	B	762	 2% 87% 6% 6%

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	B12	A	3001	X	-	X	-
2	B12	B	3001	X	-	-	-
3	5AD	A	4001[A]	-	-	-	X
3	5AD	A	4001[B]	-	-	X	X
3	5AD	B	4001[A]	-	-	-	X
3	5AD	B	4001[B]	-	-	X	X

## 2 Entry composition [i](#)

There are 5 unique types of molecules in this entry. The entry contains 12511 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	A	714	Total	C	N	O	S	0	3	0
			5531	3497	957	1045	32			
1	B	713	Total	C	N	O	S	0	2	0
			5512	3486	953	1041	32			

There are 48 discrepancies between the modelled and reference sequences:

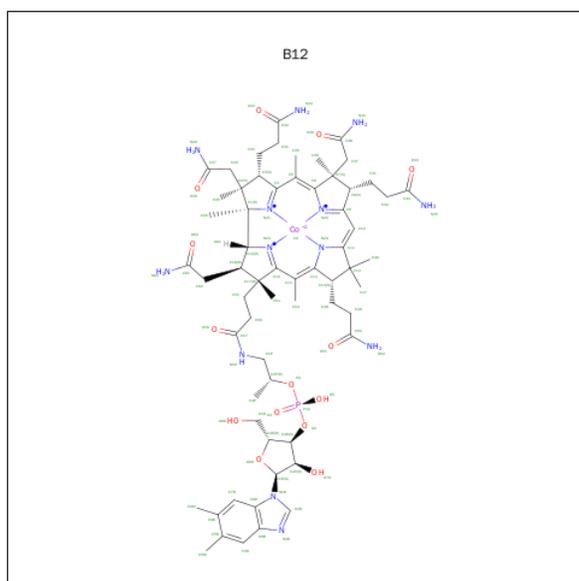
Chain	Residue	Modelled	Actual	Comment	Reference
A	11	MET	-	EXPRESSION TAG	UNP P22033
A	751	ALA	-	EXPRESSION TAG	UNP P22033
A	752	GLU	-	EXPRESSION TAG	UNP P22033
A	753	ASN	-	EXPRESSION TAG	UNP P22033
A	754	LEU	-	EXPRESSION TAG	UNP P22033
A	755	TYR	-	EXPRESSION TAG	UNP P22033
A	756	PHE	-	EXPRESSION TAG	UNP P22033
A	757	GLN	-	EXPRESSION TAG	UNP P22033
A	758	SER	-	EXPRESSION TAG	UNP P22033
A	759	HIS	-	EXPRESSION TAG	UNP P22033
A	760	HIS	-	EXPRESSION TAG	UNP P22033
A	761	HIS	-	EXPRESSION TAG	UNP P22033
A	762	HIS	-	EXPRESSION TAG	UNP P22033
A	763	HIS	-	EXPRESSION TAG	UNP P22033
A	764	HIS	-	EXPRESSION TAG	UNP P22033
A	765	ASP	-	EXPRESSION TAG	UNP P22033
A	766	TYR	-	EXPRESSION TAG	UNP P22033
A	767	LYS	-	EXPRESSION TAG	UNP P22033
A	768	ASP	-	EXPRESSION TAG	UNP P22033
A	769	ASP	-	EXPRESSION TAG	UNP P22033
A	770	ASP	-	EXPRESSION TAG	UNP P22033
A	771	ASP	-	EXPRESSION TAG	UNP P22033
A	772	LYS	-	EXPRESSION TAG	UNP P22033
A	499	THR	ALA	CONFLICT	UNP P22033
B	11	MET	-	EXPRESSION TAG	UNP P22033

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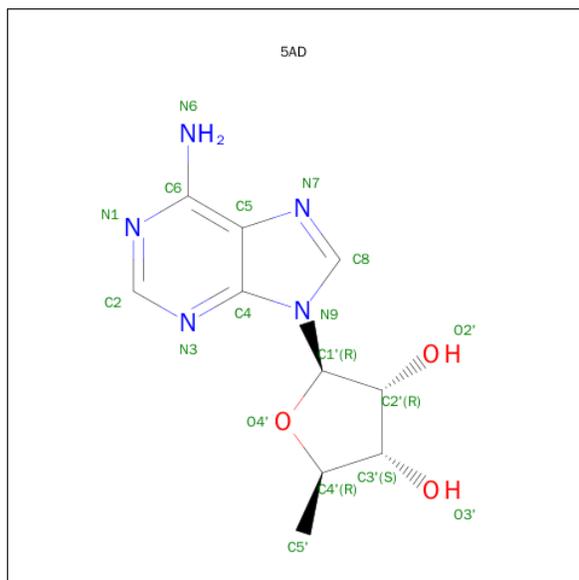
Chain	Residue	Modelled	Actual	Comment	Reference
B	751	ALA	-	EXPRESSION TAG	UNP P22033
B	752	GLU	-	EXPRESSION TAG	UNP P22033
B	753	ASN	-	EXPRESSION TAG	UNP P22033
B	754	LEU	-	EXPRESSION TAG	UNP P22033
B	755	TYR	-	EXPRESSION TAG	UNP P22033
B	756	PHE	-	EXPRESSION TAG	UNP P22033
B	757	GLN	-	EXPRESSION TAG	UNP P22033
B	758	SER	-	EXPRESSION TAG	UNP P22033
B	759	HIS	-	EXPRESSION TAG	UNP P22033
B	760	HIS	-	EXPRESSION TAG	UNP P22033
B	761	HIS	-	EXPRESSION TAG	UNP P22033
B	762	HIS	-	EXPRESSION TAG	UNP P22033
B	763	HIS	-	EXPRESSION TAG	UNP P22033
B	764	HIS	-	EXPRESSION TAG	UNP P22033
B	765	ASP	-	EXPRESSION TAG	UNP P22033
B	766	TYR	-	EXPRESSION TAG	UNP P22033
B	767	LYS	-	EXPRESSION TAG	UNP P22033
B	768	ASP	-	EXPRESSION TAG	UNP P22033
B	769	ASP	-	EXPRESSION TAG	UNP P22033
B	770	ASP	-	EXPRESSION TAG	UNP P22033
B	771	ASP	-	EXPRESSION TAG	UNP P22033
B	772	LYS	-	EXPRESSION TAG	UNP P22033
B	499	THR	ALA	CONFLICT	UNP P22033

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



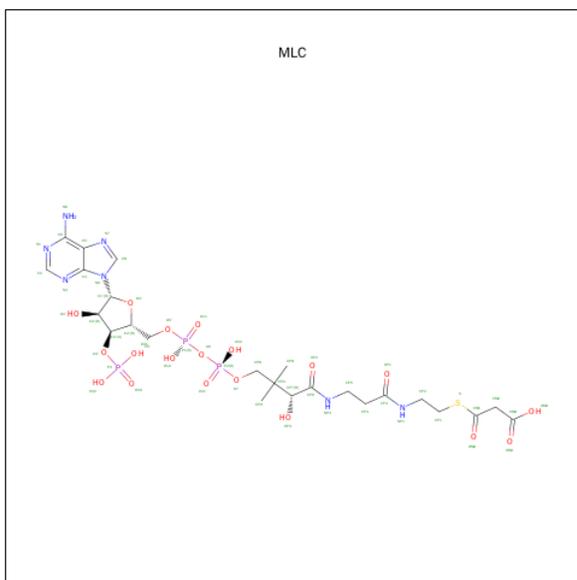
Mol	Chain	Residues	Atoms					ZeroOcc	AltConf	
			Total	C	Co	N	O			P
2	A	1	91	62	1	13	14	1	0	0
2	B	1	91	62	1	13	14	1	0	0

- Molecule 3 is 5'-DEOXYADENOSINE (three-letter code: 5AD) (formula: C<sub>10</sub>H<sub>13</sub>N<sub>5</sub>O<sub>3</sub>).



Mol	Chain	Residues	Atoms				ZeroOcc	AltConf
			Total	C	N	O		
3	A	1	36	20	10	6	0	1
3	B	1	36	20	10	6	0	1

- Molecule 4 is MALONYL-COENZYME A (three-letter code: MLC) (formula: C<sub>24</sub>H<sub>38</sub>N<sub>7</sub>O<sub>19</sub>P<sub>3</sub>S).



Mol	Chain	Residues	Atoms					ZeroOcc	AltConf	
			Total	C	N	O	P			S
4	A	1	54	24	7	19	3	1	0	0
4	B	1	54	24	7	19	3	1	0	0

- Molecule 5 is water.

Mol	Chain	Residues	Atoms	ZeroOcc	AltConf
5	A	494	Total O 494 494	0	0
5	B	612	Total O 612 612	0	0



## 4 Data and refinement statistics

Property	Value	Source
Space group	P 21 21 21	Depositor
Cell constants a, b, c, $\alpha$ , $\beta$ , $\gamma$	75.65Å 143.62Å 163.23Å 90.00° 90.00° 90.00°	Depositor
Resolution (Å)	107.82 – 1.95 52.08 – 1.95	Depositor EDS
% Data completeness (in resolution range)	99.2 (107.82-1.95) 99.2 (52.08-1.95)	Depositor EDS
$R_{merge}$	0.11	Depositor
$R_{sym}$	(Not available)	Depositor
$\langle I/\sigma(I) \rangle$ <sup>1</sup>	1.97 (at 1.95Å)	Xtrriage
Refinement program	REFMAC 5.6.0066	Depositor
R, $R_{free}$	0.161 , 0.201 0.161 , 0.200	Depositor DCC
$R_{free}$ test set	6447 reflections (5.26%)	DCC
Wilson B-factor (Å <sup>2</sup> )	25.1	Xtrriage
Anisotropy	0.825	Xtrriage
Bulk solvent $k_{sol}$ (e/Å <sup>3</sup> ), $B_{sol}$ (Å <sup>2</sup> )	0.34 , 44.9	EDS
Estimated twinning fraction	No twinning to report.	Xtrriage
L-test for twinning <sup>2</sup>	$\langle  L  \rangle = 0.49$ , $\langle L^2 \rangle = 0.32$	Xtrriage
Outliers	0 of 128908 reflections	Xtrriage
$F_o, F_c$ correlation	0.97	EDS
Total number of atoms	12511	wwPDB-VP
Average B, all atoms (Å <sup>2</sup> )	33.0	wwPDB-VP

Xtrriage's analysis on translational NCS is as follows: *The largest off-origin peak in the Patterson function is 5.97% 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, 0.375 respectively for untwinned datasets, and 0.333, 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: MLC, B12, 5AD

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	0.68	2/5646 (0.0%)	0.51	0/7634
1	B	0.71	0/5624	0.54	0/7606
All	All	0.70	2/11270 (0.0%)	0.52	0/15240

All (2) bond length outliers are listed below:

Mol	Chain	Res	Type	Atoms	Z	Observed(Å)	Ideal(Å)
1	A	539	GLU	CD-OE2	10.63	1.37	1.25
1	A	539	GLU	CD-OE1	-6.50	1.18	1.25

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	5531	0	5521	46	0
1	B	5512	0	5497	39	0
2	A	91	0	87	21	0
2	B	91	0	87	18	0
3	A	36	0	26	11	0
3	B	36	0	26	12	0
4	A	54	0	33	2	0

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Mol	Chain	Non-H	H(model)	H(added)	Clashes	Symm-Clashes
4	B	54	0	34	4	0
5	A	494	0	0	17	1
5	B	612	0	0	11	1
All	All	12511	0	11311	117	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 5.

The worst 5 of 117 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)
2:B:3001:B12:H531	2:B:3001:B12:H552	1.34	1.09
2:A:3001:B12:H552	2:A:3001:B12:H531	1.45	0.97
1:A:465:LYS:NZ	5:A:2296:HOH:O	1.94	0.95
1:A:656:GLU:HG3	5:A:2428:HOH:O	1.71	0.90
2:A:3001:B12:H372	3:A:4001[B]:5AD:H2	1.52	0.89

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:2219:HOH:O	5:B:2334:HOH:O[2_565]	2.17	0.03

## 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	715/762 (94%)	702 (98%)	12 (2%)	1 (0%)	56	48
1	B	713/762 (94%)	699 (98%)	14 (2%)	0	100	100
All	All	1428/1524 (94%)	1401 (98%)	26 (2%)	1 (0%)	56	48

All (1) Ramachandran outliers are listed below:

Mol	Chain	Res	Type
1	A	37	GLN

### 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	583/636 (92%)	579 (99%)	4 (1%)	88	88
1	B	580/636 (91%)	574 (99%)	6 (1%)	82	80
All	All	1163/1272 (91%)	1153 (99%)	10 (1%)	84	83

5 of 10 residues with a non-rotameric sidechain are listed below:

Mol	Chain	Res	Type
1	B	103	ARG
1	B	293	GLN
1	B	521	ILE
1	A	720	ASN
1	B	336	MET

Some sidechains can be flipped to improve hydrogen bonding and reduce clashes. All (5) such sidechains are listed below:

Mol	Chain	Res	Type
1	A	37	GLN
1	A	314	ASN
1	A	605	HIS
1	B	293	GLN
1	B	314	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 carbohydrates in this entry.

## 5.6 Ligand geometry [i](#)

8 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	B12	A	3001	1	74,101,101	1.17	5 (6%)	111,166,166	1.63	15 (13%)
3	5AD	A	4001[A]	-	15,20,20	3.16	5 (33%)	14,30,30	5.78	4 (28%)
3	5AD	A	4001[B]	-	15,20,20	2.90	5 (33%)	14,30,30	5.70	6 (42%)
4	MLC	A	5001	-	42,56,56	2.18	10 (23%)	54,83,83	3.02	6 (11%)
2	B12	B	3001	1	74,101,101	1.17	6 (8%)	111,166,166	1.60	11 (9%)
3	5AD	B	4001[A]	-	15,20,20	3.11	5 (33%)	14,30,30	5.73	6 (42%)
3	5AD	B	4001[B]	-	15,20,20	3.00	6 (40%)	14,30,30	5.68	6 (42%)
4	MLC	B	5001	-	42,56,56	1.97	7 (16%)	54,83,83	2.80	6 (11%)

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	A	3001	1	1/1/36/38	0/51/223/223	0/3/11/11
3	5AD	A	4001[A]	-	-	0/0/20/20	0/3/3/3
3	5AD	A	4001[B]	-	-	0/0/20/20	0/3/3/3
4	MLC	A	5001	-	-	0/48/71/71	0/3/3/3
2	B12	B	3001	1	1/1/36/38	0/51/223/223	0/3/11/11

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Mol	Type	Chain	Res	Link	Chirals	Torsions	Rings
3	5AD	B	4001[A]	-	-	0/0/20/20	0/3/3/3
3	5AD	B	4001[B]	-	-	0/0/20/20	0/3/3/3
4	MLC	B	5001	-	-	0/48/71/71	0/3/3/3

The worst 5 of 49 bond length outliers are listed below:

Mol	Chain	Res	Type	Atoms	Z	Observed(Å)	Ideal(Å)
3	A	4001[A]	5AD	C3'-C4'	-9.50	1.41	1.53
3	B	4001[A]	5AD	C3'-C4'	-9.22	1.41	1.53
3	B	4001[B]	5AD	C3'-C4'	-8.97	1.41	1.53
3	A	4001[B]	5AD	C3'-C4'	-8.46	1.42	1.53
3	A	4001[A]	5AD	C3'-C2'	-5.07	1.39	1.53

The worst 5 of 60 bond angle outliers are listed below:

Mol	Chain	Res	Type	Atoms	Z	Observed(°)	Ideal(°)
4	A	5001	MLC	OM2-CM1-S	-18.19	108.40	122.83
3	A	4001[A]	5AD	C1'-N9-C4	-17.33	100.80	126.94
3	B	4001[A]	5AD	C1'-N9-C4	-17.04	101.23	126.94
4	B	5001	MLC	OM2-CM1-S	-16.85	109.46	122.83
3	B	4001[B]	5AD	C1'-N9-C4	-15.84	103.05	126.94

All (2) chirality outliers are listed below:

Mol	Chain	Res	Type	Atom
2	B	3001	B12	C19
2	A	3001	B12	C19

There are no torsion outliers.

There are no ring outliers.

8 monomers are involved in 52 short contacts:

Mol	Chain	Res	Type	Clashes	Symm-Clashes
2	A	3001	B12	21	0
3	A	4001[A]	5AD	4	0
3	A	4001[B]	5AD	7	0
4	A	5001	MLC	2	0
2	B	3001	B12	18	0
3	B	4001[A]	5AD	5	0
3	B	4001[B]	5AD	7	0
4	B	5001	MLC	4	0

## 5.7 Other polymers

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	714/762 (93%)	0.01	17 (2%) 62 72	19, 33, 62, 93	0
1	B	713/762 (93%)	-0.17	15 (2%) 67 75	14, 26, 51, 87	0
All	All	1427/1524 (93%)	-0.08	32 (2%) 65 74	14, 30, 57, 93	0

The worst 5 of 32 RSRZ outliers are listed below:

Mol	Chain	Res	Type	RSRZ
1	B	36	GLN	5.1
1	A	36	GLN	4.8
1	A	749	SER	4.1
1	B	742	CYS	3.6
1	B	51	LEU	3.4

### 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 carbohydrates 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. LLDF column lists the quality of electron density of the group with respect to its neighbouring residues in protein, DNA or RNA chains. 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	LLDF	B-factors( $\text{\AA}^2$ )	Q<0.9
3	5AD	B	4001[B]	18/18	0.64	0.40	10.92	33,75,120,137	18
3	5AD	B	4001[A]	18/18	0.64	0.40	10.77	38,58,74,78	18
3	5AD	A	4001[B]	18/18	0.57	0.45	9.10	36,58,87,88	18
3	5AD	A	4001[A]	18/18	0.57	0.45	8.95	56,106,143,145	18
2	B12	B	3001	91/91	0.97	0.12	1.05	12,19,24,33	0
2	B12	A	3001	91/91	0.97	0.12	0.88	15,22,31,35	0
4	MLC	B	5001	54/54	0.97	0.10	0.04	13,21,34,53	0
4	MLC	A	5001	54/54	0.95	0.11	-0.32	18,28,41,49	0

## 6.5 Other polymers [i](#)

There are no such residues in this entry.