



# Full wwPDB X-ray Structure Validation Report ⓘ

May 16, 2020 – 02:22 am BST

PDB ID : 5J2N  
Title : HIV-1 reverse transcriptase in complex with DNA that has incorporated EFdA-MP at the P-(post-translocation) site and dTMP at the N-(pre-translocation) site  
Authors : Salie, Z.L.; Kirby, K.A.; Sarafianos, S.G.  
Deposited on : 2016-03-29  
Resolution : 2.90 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](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.

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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 : 1.8.5 (274361), CSD as541be (2020)  
Xtriage (Phenix) : 1.13  
EDS : 2.11  
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) : 2.11

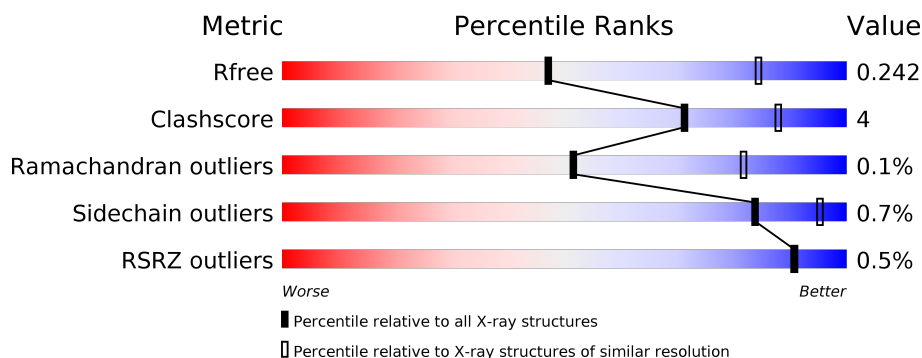
# 1 Overall quality at a glance

The following experimental techniques were used to determine the structure:

## *X-RAY DIFFRACTION*

The reported resolution of this entry is 2.90 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	1957 (2.90-2.90)
Clashscore	141614	2172 (2.90-2.90)
Ramachandran outliers	138981	2115 (2.90-2.90)
Sidechain outliers	138945	2117 (2.90-2.90)
RSRZ outliers	127900	1906 (2.90-2.90)

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 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	560	 88% 11%
2	B	440	 82% 10% 8%
3	P	22	 68% 18% 14%
4	T	27	 70% 15% 15%

## 2 Entry composition

There are 6 unique types of molecules in this entry. The entry contains 8756 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 reverse transcriptase, p66 domain.

Mol	Chain	Residues	Atoms					ZeroOcc	AltConf	Trace
1	A	558	Total	C	N	O	S	14	0	0
			4542	2935	760	839	8			

There are 2 discrepancies between the modelled and reference sequences:

Chain	Residue	Modelled	Actual	Comment	Reference
A	258	CYS	GLN	engineered mutation	UNP P04585
A	280	SER	CYS	engineered mutation	UNP P04585

- Molecule 2 is a protein called reverse transcriptase, p51 domain.

Mol	Chain	Residues	Atoms					ZeroOcc	AltConf	Trace
2	B	405	Total	C	N	O	S	7	0	0
			3337	2168	556	606	7			

There is a discrepancy between the modelled and reference sequences:

Chain	Residue	Modelled	Actual	Comment	Reference
B	280	SER	CYS	engineered mutation	UNP P04585

- Molecule 3 is a DNA chain called DNA 5'-D(\*AP\*CP\*AP\*GP\*TP\*CP\*CP\*CP\*TP\*GP\*T  
P\*TP\*CP\*GP\*GP\*(MRG)P\*CP\*GP\*CP\*CP\*G)-3'.

Mol	Chain	Residues	Atoms							ZeroOcc	AltConf	Trace
3	P	19	Total	C	F	N	O	P	S	0	0	0
			393	188	1	66	118	19	1			

- Molecule 4 is a DNA chain called DNA (27-MER).

Mol	Chain	Residues	Atoms					ZeroOcc	AltConf	Trace
4	T	23	Total	C	N	O	P	0	0	0
			479	224	97	135	23			

- Molecule 5 is MAGNESIUM ION (three-letter code: MG) (formula: Mg).

Mol	Chain	Residues	Atoms		ZeroOcc	AltConf
5	A	1	Total	Mg	0	0
			1	1		

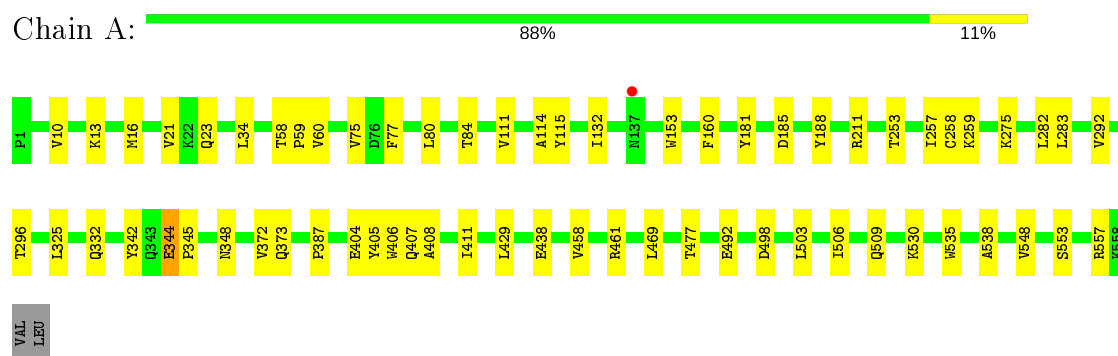
- Molecule 6 is water.

Mol	Chain	Residues	Atoms		ZeroOcc	AltConf
6	A	3	Total	O	0	0
			3	3		
6	T	1	Total	O	0	0
			1	1		

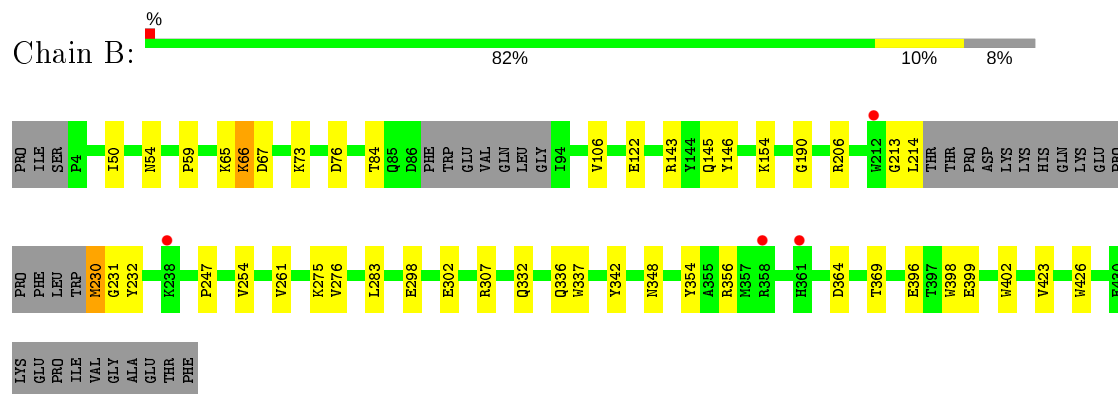
### 3 Residue-property plots [i](#)

These plots are drawn for all protein, RNA and DNA 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.

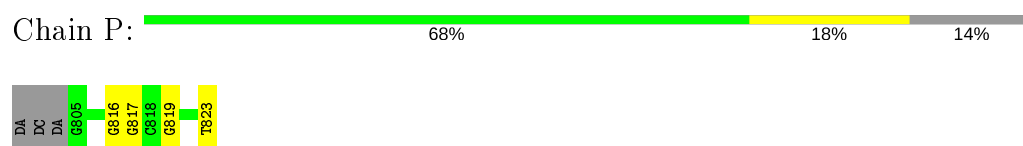
- Molecule 1: reverse transcriptase, p66 domain



- Molecule 2: reverse transcriptase, p51 domain



- Molecule 3: DNA 5'-D(\*AP\*CP\*AP\*GP\*TP\*CP\*CP\*CP\*TP\*GP\*TP\*TP\*CP\*GP\*GP\*(MR G)P\*CP\*GP\*CP\*CP\*G)-3'



- Molecule 4: DNA (27-MER)





## 4 Data and refinement statistics

Property	Value	Source
Space group	C 2 2 21	Depositor
Cell constants a, b, c, $\alpha$ , $\beta$ , $\gamma$	166.83Å 169.88Å 102.66Å 90.00° 90.00° 90.00°	Depositor
Resolution (Å)	53.62 – 2.90 53.62 – 2.88	Depositor EDS
% Data completeness (in resolution range)	99.6 (53.62-2.90) 99.0 (53.62-2.88)	Depositor EDS
$R_{merge}$	0.14	Depositor
$R_{sym}$	(Not available)	Depositor
$\langle I/\sigma(I) \rangle$ <sup>1</sup>	1.64 (at 2.91Å)	Xtriage
Refinement program	PHENIX 1.10.1_2155	Depositor
R, $R_{free}$	0.212 , 0.242 0.212 , 0.242	Depositor DCC
$R_{free}$ test set	1607 reflections (4.89%)	wwPDB-VP
Wilson B-factor (Å <sup>2</sup> )	54.1	Xtriage
Anisotropy	0.429	Xtriage
Bulk solvent $k_{sol}$ (e/Å <sup>3</sup> ), $B_{sol}$ (Å <sup>2</sup> )	0.28 , 25.1	EDS
L-test for twinning <sup>2</sup>	$\langle  L  \rangle = 0.49$ , $\langle L^2 \rangle = 0.32$	Xtriage
Estimated twinning fraction	0.018 for -k,-h,-l	Xtriage
$F_o, F_c$ correlation	0.93	EDS
Total number of atoms	8756	wwPDB-VP
Average B, all atoms (Å <sup>2</sup> )	57.0	wwPDB-VP

Xtriage's analysis on translational NCS is as follows: *The largest off-origin peak in the Patterson function is 2.98% 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

### 5.1 Standard geometry

Bond lengths and bond angles in the following residue types are not validated in this section: 6FM, MRG, MG

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	0.23	0/4659	0.41	0/6328
2	B	0.24	0/3428	0.41	0/4654
3	P	0.51	0/379	0.93	0/577
4	T	0.49	0/539	0.78	0/831
All	All	0.27	0/9005	0.48	0/12390

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	A	4542	0	4599	35	0
2	B	3337	0	3371	23	0
3	P	393	0	209	5	0
4	T	479	0	256	2	0
5	A	1	0	0	0	0
6	A	3	0	0	0	0
6	T	1	0	0	0	0
All	All	8756	0	8435	60	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 4.

All (60) 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:344:GLU:HG2	1:A:345:PRO:HD2	1.75	0.68
2:B:275:LYS:HE3	2:B:302:GLU:HG3	1.78	0.65
2:B:59:PRO:HG2	2:B:76:ASP:HB3	1.87	0.55
1:A:372:VAL:HG11	1:A:411:ILE:HG23	1.88	0.55
1:A:181:TYR:HB2	1:A:188:TYR:HB3	1.88	0.54
3:P:816:DG:H2'	3:P:817:MRG:C8	2.38	0.54
2:B:423:VAL:HA	2:B:426:TRP:CD1	2.43	0.53
2:B:50:ILE:HD13	2:B:145:GLN:HB3	1.91	0.52
2:B:337:TRP:O	2:B:354:TYR:N	2.42	0.52
1:A:60:VAL:HG12	1:A:75:VAL:HG22	1.92	0.51
1:A:34:LEU:HB3	1:A:132:ILE:HD13	1.92	0.51
1:A:282:LEU:HD21	1:A:296:THR:HG23	1.93	0.50
1:A:80:LEU:O	1:A:84:THR:OG1	2.25	0.49
1:A:503:LEU:HD22	1:A:535:TRP:HB2	1.93	0.49
1:A:492:GLU:HG2	1:A:530:LYS:HB2	1.95	0.49
1:A:21:VAL:HB	1:A:59:PRO:HD3	1.95	0.49
1:A:408:ALA:HB1	2:B:364:ASP:HB3	1.94	0.49
1:A:23:GLN:HE22	1:A:60:VAL:H	1.59	0.49
2:B:254:VAL:HG13	2:B:283:LEU:HD22	1.96	0.47
2:B:66:LYS:HG3	2:B:67:ASP:H	1.77	0.47
4:T:713:DC:H2'	4:T:714:DG:C8	2.50	0.47
1:A:58:THR:HG21	1:A:77:PHE:CD1	2.50	0.47
1:A:258:CYS:HA	3:P:817:MRG:H231	1.96	0.47
3:P:816:DG:H2'	3:P:817:MRG:H8	1.96	0.47
1:A:275:LYS:HD2	1:A:332:GLN:HG2	1.97	0.46
2:B:73:LYS:NZ	2:B:146:TYR:OH	2.48	0.46
4:T:707:DG:H2'	4:T:708:DG:C8	2.50	0.46
1:A:404:GLU:OE2	1:A:509:GLN:NE2	2.44	0.46
2:B:332:GLN:HB2	2:B:336:GLN:HB2	1.98	0.46
1:A:325:LEU:HB3	1:A:387:PRO:HB3	1.97	0.45
1:A:498:ASP:HB2	1:A:538:ALA:HB2	1.98	0.45
2:B:65:LYS:HZ3	2:B:230:MET:N	2.15	0.45
2:B:231:GLY:HA2	2:B:232:TYR:HA	1.59	0.45
1:A:406:TRP:CD1	1:A:407:GLN:HG3	2.52	0.45
1:A:10:VAL:HG21	1:A:153:TRP:HH2	1.81	0.45
1:A:553:SER:OG	1:A:557:ARG:NH2	2.50	0.45
1:A:458:VAL:HG22	1:A:548:VAL:HB	1.99	0.45
1:A:13:LYS:HB2	1:A:16:MET:HG3	1.99	0.44

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Atom-1	Atom-2	Interatomic distance (Å)	Clash overlap (Å)
1:A:257:ILE:HB	1:A:283:LEU:HD21	1.99	0.44
1:A:469:LEU:HD12	1:A:477:THR:HG22	2.00	0.44
2:B:247:PRO:O	2:B:307:ARG:NH2	2.50	0.44
2:B:261:VAL:HG13	2:B:276:VAL:HG21	1.99	0.44
1:A:253:THR:HA	1:A:292:VAL:HA	2.01	0.43
1:A:114:ALA:HB1	1:A:160:PHE:CZ	2.54	0.43
1:A:438:GLU:HG3	1:A:461:ARG:HG3	2.00	0.43
2:B:354:TYR:CZ	2:B:356:ARG:HD3	2.54	0.43
1:A:342:TYR:HB3	1:A:348:ASN:HA	2.01	0.43
1:A:111:VAL:HB	1:A:185:ASP:HB2	2.01	0.42
1:A:259:LYS:HA	3:P:819:DG:H5'	2.01	0.41
2:B:54:ASN:HB3	2:B:143:ARG:HH21	1.85	0.41
2:B:342:TYR:HB3	2:B:348:ASN:HA	2.03	0.41
2:B:399:GLU:HA	2:B:402:TRP:HD1	1.85	0.41
1:A:115:TYR:CG	3:P:823:DT:H2''	2.55	0.41
2:B:369:THR:HG22	2:B:398:TRP:CH2	2.56	0.41
2:B:106:VAL:HG22	2:B:190:GLY:HA3	2.03	0.41
2:B:84:THR:HB	2:B:154:LYS:HE2	2.03	0.41
1:A:405:TYR:CE2	1:A:407:GLN:HB2	2.56	0.40
1:A:373:GLN:NE2	2:B:396:GLU:HB2	2.36	0.40
1:A:429:LEU:HD11	1:A:506:ILE:HG22	2.02	0.40
2:B:213:GLY:HA2	2:B:214:LEU:HA	1.51	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	A	556/560 (99%)	528 (95%)	28 (5%)	0	100	100
2	B	399/440 (91%)	376 (94%)	22 (6%)	1 (0%)	41	71
All	All	955/1000 (96%)	904 (95%)	50 (5%)	1 (0%)	51	82

All (1) Ramachandran outliers are listed below:

Mol	Chain	Res	Type
2	B	66	LYS

### 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	498/500 (100%)	496 (100%)	2 (0%)	91	97
2	B	366/400 (92%)	362 (99%)	4 (1%)	73	92
All	All	864/900 (96%)	858 (99%)	6 (1%)	84	95

All (6) residues with a non-rotameric sidechain are listed below:

Mol	Chain	Res	Type
1	A	211	ARG
1	A	344	GLU
2	B	122	GLU
2	B	206	ARG
2	B	230	MET
2	B	298	GLU

Some sidechains can be flipped to improve hydrogen bonding and reduce clashes. There are no such sidechains identified.

### 5.3.3 RNA ⓘ

There are no RNA molecules in this entry.

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

2 non-standard protein/DNA/RNA residues 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	MRG	P	817	1,3,4	22,28,29	1.81	3 (13%)	23,39,42	1.50	4 (17%)
3	6FM	P	822	3	19,26,27	2.24	8 (42%)	10,39,42	4.08	6 (60%)

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	MRG	P	817	1,3,4	-	0/8/26/27	0/3/3/3
3	6FM	P	822	3	-	0/4/37/38	0/3/3/3

All (11) bond length outliers are listed below:

Mol	Chain	Res	Type	Atoms	Z	Observed(Å)	Ideal(Å)
3	P	822	6FM	O4'-C1'	5.03	1.50	1.43
3	P	817	MRG	O6-C6	4.42	1.35	1.24
3	P	817	MRG	C2-N2	4.32	1.41	1.34
3	P	822	6FM	C2'-C3'	-3.34	1.45	1.53
3	P	822	6FM	C6-N6	3.20	1.45	1.34
3	P	822	6FM	C2-N1	3.19	1.34	1.31
3	P	822	6FM	C4'-C33	2.98	1.51	1.48
3	P	822	6FM	C4-N3	-2.60	1.31	1.35
3	P	822	6FM	C1'-N9	-2.53	1.41	1.49
3	P	817	MRG	C2-N3	2.22	1.41	1.34
3	P	822	6FM	C2-N3	2.21	1.33	1.31

All (10) bond angle outliers are listed below:

Mol	Chain	Res	Type	Atoms	Z	Observed(°)	Ideal(°)
3	P	822	6FM	N3-C2-N1	-6.74	120.95	130.51
3	P	817	MRG	C6-C5-C4	-5.44	115.61	120.80
3	P	822	6FM	F32-C2-N1	5.10	119.58	114.73
3	P	822	6FM	F32-C2-N3	4.99	119.47	114.73
3	P	822	6FM	C4-C5-N7	-4.87	104.33	109.40
3	P	822	6FM	C5-C6-N1	-4.78	117.87	121.01
3	P	822	6FM	C2-N3-C4	4.14	120.07	115.03

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Mol	Chain	Res	Type	Atoms	Z	Observed(°)	Ideal(°)
3	P	817	MRG	C4-C5-N7	2.55	112.05	109.40
3	P	817	MRG	C22-C21-N2	2.14	117.23	111.49
3	P	817	MRG	C2'-C3'-C4'	-2.06	98.46	102.76

There are no chirality outliers.

There are no torsion outliers.

There are no ring outliers.

1 monomer is involved in 3 short contacts:

Mol	Chain	Res	Type	Clashes	Symm-Clashes
3	P	817	MRG	3	0

## 5.5 Carbohydrates [i](#)

There are no carbohydrates in this entry.

## 5.6 Ligand geometry [i](#)

Of 1 ligands modelled in this entry, 1 is monoatomic - leaving 0 for Mogul analysis.

There are no bond length outliers.

There are no bond angle outliers.

There are no chirality outliers.

There are no torsion outliers.

There are no ring outliers.

No monomer is involved in short contacts.

## 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, 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	558/560 (99%)	-0.21	1 (0%) 95 95	30, 45, 94, 141	4 (0%)
2	B	405/440 (92%)	-0.11	4 (0%) 82 82	37, 55, 103, 138	1 (0%)
3	P	17/22 (77%)	-0.68	0 100 100	46, 60, 75, 77	0
4	T	23/27 (85%)	-0.41	0 100 100	45, 67, 102, 159	0
All	All	1003/1049 (95%)	-0.18	5 (0%) 91 91	30, 50, 98, 159	5 (0%)

All (5) RSRZ outliers are listed below:

Mol	Chain	Res	Type	RSRZ
1	A	137	ASN	4.0
2	B	212	TRP	3.1
2	B	358	ARG	2.8
2	B	238	LYS	2.1
2	B	361	HIS	2.1

### 6.2 Non-standard residues in protein, DNA, RNA chains [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	MRG	P	817	26/27	0.93	0.17	56,66,85,88	0
3	6FM	P	822	24/25	0.97	0.15	41,49,58,63	0

### 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. 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( $\text{\AA}^2$ )	Q<0.9
5	MG	A	601	1/1	0.98	0.20	29,29,29,29	0

## 6.5 Other polymers [i](#)

There are no such residues in this entry.