



# wwPDB X-ray Structure Validation Summary Report ⓘ

May 21, 2020 – 08:20 pm BST

PDB ID : 4XSE  
Title : Complex structure of thymidylate synthase from varicella zoster virus  
Authors : Hew, K.  
Deposited on : 2015-01-22  
Resolution : 3.10 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

<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

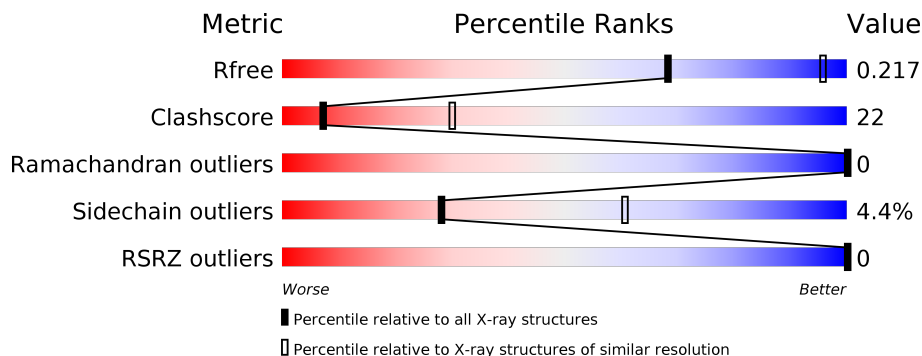
# 1 Overall quality at a glance

The following experimental techniques were used to determine the structure:

*X-RAY DIFFRACTION*

The reported resolution of this entry is 3.10 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	1094 (3.10-3.10)
Clashscore	141614	1184 (3.10-3.10)
Ramachandran outliers	138981	1141 (3.10-3.10)
Sidechain outliers	138945	1141 (3.10-3.10)
RSRZ outliers	127900	1067 (3.10-3.10)

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	311	
1	B	311	
1	C	311	
1	D	311	

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 crite-

ria:

<b>Mol</b>	<b>Type</b>	<b>Chain</b>	<b>Res</b>	<b>Chirality</b>	<b>Geometry</b>	<b>Clashes</b>	<b>Electron density</b>
2	PO4	A	1001	-	-	X	-
2	PO4	D	1002	-	-	X	-

## 2 Entry composition i

There are 2 unique types of molecules in this entry. The entry contains 9091 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 Thymidylate synthase.

Mol	Chain	Residues	Atoms					ZeroOcc	AltConf	Trace
			Total	C	N	O	S			
1	C	279	2263	1456	395	402	10	0	0	0
1	B	279	2277	1462	402	403	10	0	1	0
1	D	279	2266	1456	398	402	10	0	0	0
1	A	279	2265	1454	398	403	10	0	0	0

There are 92 discrepancies between the modelled and reference sequences:

Chain	Residue	Modelled	Actual	Comment	Reference
C	-15	MET	-	initiating methionine	UNP Q4JQW2
C	-14	HIS	-	expression tag	UNP Q4JQW2
C	-13	HIS	-	expression tag	UNP Q4JQW2
C	-12	HIS	-	expression tag	UNP Q4JQW2
C	-11	HIS	-	expression tag	UNP Q4JQW2
C	-10	HIS	-	expression tag	UNP Q4JQW2
C	-9	HIS	-	expression tag	UNP Q4JQW2
C	-8	SER	-	expression tag	UNP Q4JQW2
C	-7	SER	-	expression tag	UNP Q4JQW2
C	-6	GLY	-	expression tag	UNP Q4JQW2
C	-5	VAL	-	expression tag	UNP Q4JQW2
C	-4	ASP	-	expression tag	UNP Q4JQW2
C	-3	LEU	-	expression tag	UNP Q4JQW2
C	-2	GLY	-	expression tag	UNP Q4JQW2
C	-1	THR	-	expression tag	UNP Q4JQW2
C	0	GLU	-	expression tag	UNP Q4JQW2
C	1	ASN	-	expression tag	UNP Q4JQW2
C	2	LEU	-	expression tag	UNP Q4JQW2
C	3	TYR	-	expression tag	UNP Q4JQW2
C	4	PHE	-	expression tag	UNP Q4JQW2
C	5	GLN	-	expression tag	UNP Q4JQW2

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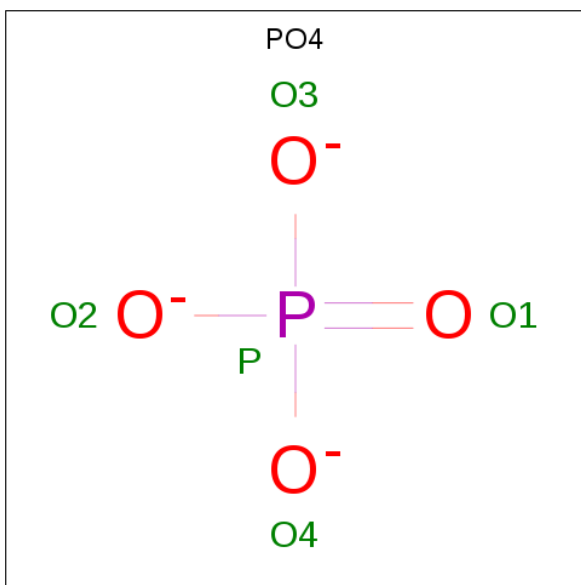
Chain	Residue	Modelled	Actual	Comment	Reference
C	6	SER	-	expression tag	UNP Q4JQW2
C	7	MET	-	expression tag	UNP Q4JQW2
B	-15	MET	-	initiating methionine	UNP Q4JQW2
B	-14	HIS	-	expression tag	UNP Q4JQW2
B	-13	HIS	-	expression tag	UNP Q4JQW2
B	-12	HIS	-	expression tag	UNP Q4JQW2
B	-11	HIS	-	expression tag	UNP Q4JQW2
B	-10	HIS	-	expression tag	UNP Q4JQW2
B	-9	HIS	-	expression tag	UNP Q4JQW2
B	-8	SER	-	expression tag	UNP Q4JQW2
B	-7	SER	-	expression tag	UNP Q4JQW2
B	-6	GLY	-	expression tag	UNP Q4JQW2
B	-5	VAL	-	expression tag	UNP Q4JQW2
B	-4	ASP	-	expression tag	UNP Q4JQW2
B	-3	LEU	-	expression tag	UNP Q4JQW2
B	-2	GLY	-	expression tag	UNP Q4JQW2
B	-1	THR	-	expression tag	UNP Q4JQW2
B	0	GLU	-	expression tag	UNP Q4JQW2
B	1	ASN	-	expression tag	UNP Q4JQW2
B	2	LEU	-	expression tag	UNP Q4JQW2
B	3	TYR	-	expression tag	UNP Q4JQW2
B	4	PHE	-	expression tag	UNP Q4JQW2
B	5	GLN	-	expression tag	UNP Q4JQW2
B	6	SER	-	expression tag	UNP Q4JQW2
B	7	MET	-	expression tag	UNP Q4JQW2
D	-15	MET	-	initiating methionine	UNP Q4JQW2
D	-14	HIS	-	expression tag	UNP Q4JQW2
D	-13	HIS	-	expression tag	UNP Q4JQW2
D	-12	HIS	-	expression tag	UNP Q4JQW2
D	-11	HIS	-	expression tag	UNP Q4JQW2
D	-10	HIS	-	expression tag	UNP Q4JQW2
D	-9	HIS	-	expression tag	UNP Q4JQW2
D	-8	SER	-	expression tag	UNP Q4JQW2
D	-7	SER	-	expression tag	UNP Q4JQW2
D	-6	GLY	-	expression tag	UNP Q4JQW2
D	-5	VAL	-	expression tag	UNP Q4JQW2
D	-4	ASP	-	expression tag	UNP Q4JQW2
D	-3	LEU	-	expression tag	UNP Q4JQW2
D	-2	GLY	-	expression tag	UNP Q4JQW2
D	-1	THR	-	expression tag	UNP Q4JQW2
D	0	GLU	-	expression tag	UNP Q4JQW2
D	1	ASN	-	expression tag	UNP Q4JQW2

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Chain	Residue	Modelled	Actual	Comment	Reference
D	2	LEU	-	expression tag	UNP Q4JQW2
D	3	TYR	-	expression tag	UNP Q4JQW2
D	4	PHE	-	expression tag	UNP Q4JQW2
D	5	GLN	-	expression tag	UNP Q4JQW2
D	6	SER	-	expression tag	UNP Q4JQW2
D	7	MET	-	expression tag	UNP Q4JQW2
A	-15	MET	-	initiating methionine	UNP Q4JQW2
A	-14	HIS	-	expression tag	UNP Q4JQW2
A	-13	HIS	-	expression tag	UNP Q4JQW2
A	-12	HIS	-	expression tag	UNP Q4JQW2
A	-11	HIS	-	expression tag	UNP Q4JQW2
A	-10	HIS	-	expression tag	UNP Q4JQW2
A	-9	HIS	-	expression tag	UNP Q4JQW2
A	-8	SER	-	expression tag	UNP Q4JQW2
A	-7	SER	-	expression tag	UNP Q4JQW2
A	-6	GLY	-	expression tag	UNP Q4JQW2
A	-5	VAL	-	expression tag	UNP Q4JQW2
A	-4	ASP	-	expression tag	UNP Q4JQW2
A	-3	LEU	-	expression tag	UNP Q4JQW2
A	-2	GLY	-	expression tag	UNP Q4JQW2
A	-1	THR	-	expression tag	UNP Q4JQW2
A	0	GLU	-	expression tag	UNP Q4JQW2
A	1	ASN	-	expression tag	UNP Q4JQW2
A	2	LEU	-	expression tag	UNP Q4JQW2
A	3	TYR	-	expression tag	UNP Q4JQW2
A	4	PHE	-	expression tag	UNP Q4JQW2
A	5	GLN	-	expression tag	UNP Q4JQW2
A	6	SER	-	expression tag	UNP Q4JQW2
A	7	MET	-	expression tag	UNP Q4JQW2

- Molecule 2 is PHOSPHATE ION (three-letter code: PO4) (formula: O<sub>4</sub>P).

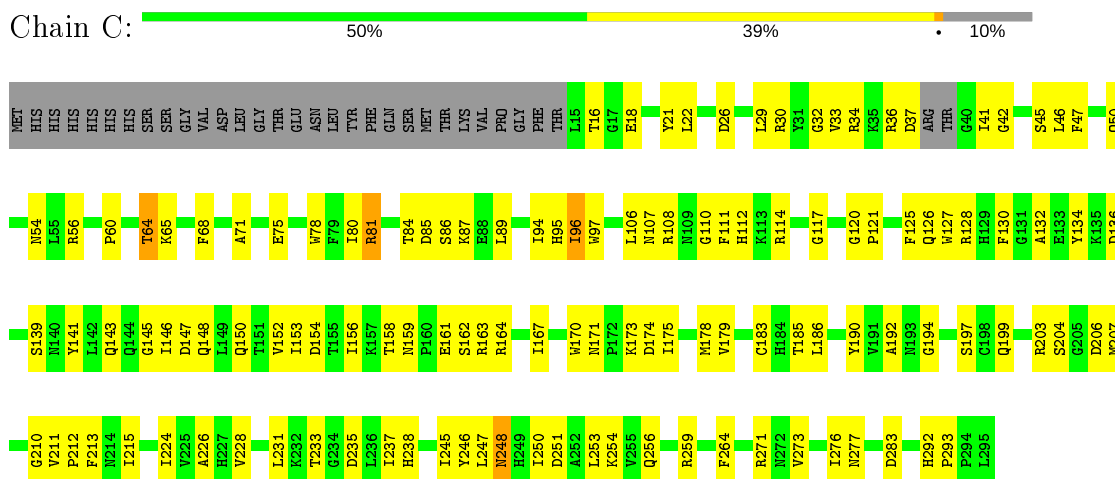


Mol	Chain	Residues	Atoms			ZeroOcc	AltConf
2	B	1	Total	O	P	0	0
			5	4	1		
2	D	1	Total	O	P	0	0
			5	4	1		
2	D	1	Total	O	P	0	0
			5	4	1		
2	A	1	Total	O	P	0	0
			5	4	1		

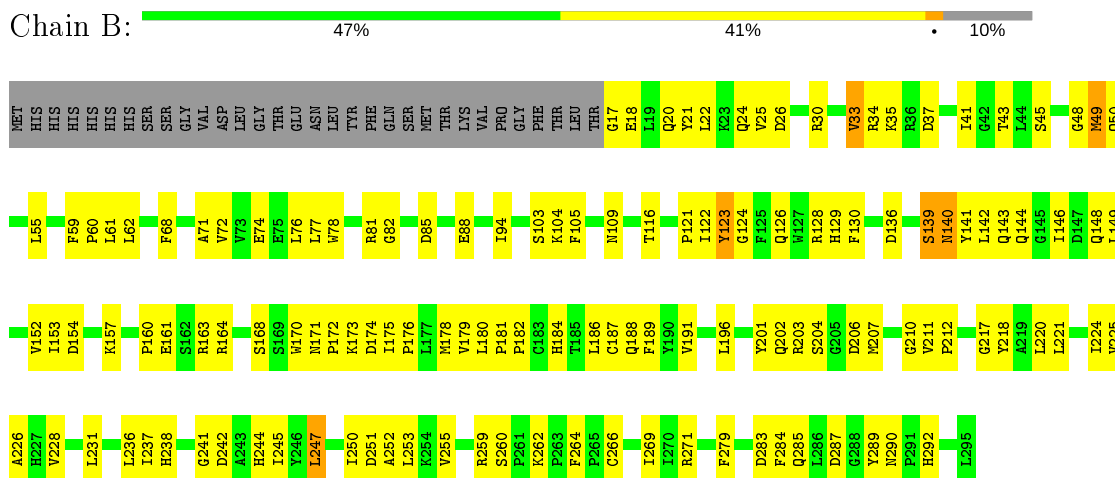
### 3 Residue-property plots

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: Thymidylate synthase



- Molecule 1: Thymidylate synthase



- Molecule 1: Thymidylate synthase







## 4 Data and refinement statistics i

Property	Value	Source
Space group	P 32	Depositor
Cell constants a, b, c, $\alpha$ , $\beta$ , $\gamma$	153.38Å 153.38Å 89.18Å 90.00° 90.00° 120.00°	Depositor
Resolution (Å)	29.73 – 3.10 29.73 – 3.10	Depositor EDS
% Data completeness (in resolution range)	99.3 (29.73-3.10) 99.3 (29.73-3.10)	Depositor EDS
$R_{merge}$	0.13	Depositor
$R_{sym}$	(Not available)	Depositor
$\langle I/\sigma(I) \rangle$ <sup>1</sup>	2.44 (at 3.11Å)	Xtriage
Refinement program	PHENIX (phenix.refine: dev_1839)	Depositor
R, $R_{free}$	0.238 , 0.268 0.194 , 0.217	Depositor DCC
$R_{free}$ test set	1968 reflections (4.66%)	wwPDB-VP
Wilson B-factor (Å <sup>2</sup> )	46.0	Xtriage
Anisotropy	0.474	Xtriage
Bulk solvent $k_{sol}$ (e/Å <sup>3</sup> ), $B_{sol}$ (Å <sup>2</sup> )	0.32 , 18.2	EDS
L-test for twinning <sup>2</sup>	$\langle  L  \rangle = 0.37$ , $\langle L^2 \rangle = 0.20$	Xtriage
Estimated twinning fraction	0.438 for -h,-k,l 0.147 for h,-h-k,-l 0.146 for -k,-h,-l	Xtriage
$F_o, F_c$ correlation	0.88	EDS
Total number of atoms	9091	wwPDB-VP
Average B, all atoms (Å <sup>2</sup> )	45.0	wwPDB-VP

Xtriage's analysis on translational NCS is as follows: *The largest off-origin peak in the Patterson function is 3.68% 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 [i](#)

### 5.1 Standard geometry [i](#)

Bond lengths and bond angles in the following residue types are not validated in this section: PO4

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	0.51	0/2326	0.72	0/3155
1	B	0.50	0/2338	0.73	1/3170 (0.0%)
1	C	0.51	0/2323	0.68	0/3150
1	D	0.50	0/2326	0.70	1/3153 (0.0%)
All	All	0.50	0/9313	0.71	2/12628 (0.0%)

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	D	0	1

There are no bond length outliers.

All (2) bond angle outliers are listed below:

Mol	Chain	Res	Type	Atoms	Z	Observed(°)	Ideal(°)
1	B	247	LEU	CA-CB-CG	7.67	132.93	115.30
1	D	241	GLY	N-CA-C	-5.69	98.87	113.10

There are no chirality outliers.

All (1) planarity outliers are listed below:

Mol	Chain	Res	Type	Group
1	D	150	GLN	Peptide

## 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	2265	0	2239	117	0
1	B	2277	0	2255	117	0
1	C	2263	0	2240	99	0
1	D	2266	0	2242	107	0
2	A	5	0	0	2	0
2	B	5	0	0	0	0
2	D	10	0	0	2	0
All	All	9091	0	8976	406	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 22.

The worst 5 of 406 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:108:ARG:HG2	1:A:109:ASN:ND2	1.77	0.99
1:B:182:PRO:O	1:B:203:ARG:NE	2.04	0.90
1:D:171:ASN:ND2	1:D:174:ASP:OD2	2.06	0.88
1:A:109:ASN:HD22	1:A:109:ASN:N	1.70	0.88
1:B:181:PRO:HD2	1:A:164:ARG:HH21	1.41	0.86

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	277/311 (89%)	263 (95%)	14 (5%)	0	100	100
1	B	278/311 (89%)	264 (95%)	14 (5%)	0	100	100
1	C	275/311 (88%)	263 (96%)	12 (4%)	0	100	100
1	D	275/311 (88%)	259 (94%)	16 (6%)	0	100	100
All	All	1105/1244 (89%)	1049 (95%)	56 (5%)	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	A	245/274 (89%)	236 (96%)	9 (4%)	34	66
1	B	246/274 (90%)	238 (97%)	8 (3%)	38	69
1	C	245/274 (89%)	230 (94%)	15 (6%)	18	49
1	D	245/274 (89%)	234 (96%)	11 (4%)	27	60
All	All	981/1096 (90%)	938 (96%)	43 (4%)	28	61

5 of 43 residues with a non-rotameric sidechain are listed below:

Mol	Chain	Res	Type
1	B	139	SER
1	D	47	PHE
1	A	260	SER
1	B	140	ASN
1	B	154	ASP

Some sidechains can be flipped to improve hydrogen bonding and reduce clashes. 5 of 11 such sidechains are listed below:

Mol	Chain	Res	Type
1	C	214	ASN
1	B	95	HIS
1	B	292	HIS

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Mol	Chain	Res	Type
1	C	199	GLN
1	B	126	GLN

### 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](#)

4 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	PO4	B	1001	-	4,4,4	0.78	0	6,6,6	0.49	0
2	PO4	D	1002	-	4,4,4	0.84	0	6,6,6	0.52	0
2	PO4	D	1001	-	4,4,4	0.89	0	6,6,6	0.53	0
2	PO4	A	1001	-	4,4,4	0.82	0	6,6,6	0.47	0

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.

2 monomers are involved in 4 short contacts:

Mol	Chain	Res	Type	Clashes	Symm-Clashes
2	D	1002	PO4	2	0
2	A	1001	PO4	2	0

## 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	279/311 (89%)	-0.33	0 100 100	25, 40, 62, 72	0
1	B	279/311 (89%)	-0.24	0 100 100	23, 45, 70, 90	0
1	C	279/311 (89%)	-0.26	0 100 100	21, 45, 64, 83	0
1	D	279/311 (89%)	-0.28	0 100 100	20, 46, 71, 103	0
All	All	1116/1244 (89%)	-0.28	0 100 100	20, 43, 67, 103	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 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(Å <sup>2</sup> )	Q<0.9
2	PO4	A	1001	5/5	0.96	0.17	57,57,65,67	0
2	PO4	D	1001	5/5	0.97	0.17	54,58,63,64	0
2	PO4	B	1001	5/5	0.98	0.17	27,32,38,40	0
2	PO4	D	1002	5/5	0.98	0.16	33,34,37,37	0



## 6.5 Other polymers

There are no such residues in this entry.