



Full wwPDB X-ray Structure Validation Report ⓘ

Mar 9, 2026 – 07:58 PM UTC

PDB ID : 1TSZ / pdb_00001tsz
Title : THYMIDYLATE SYNTHASE R179K MUTANT
Authors : Finer-Moore, J.; Stroud, R.M.
Deposited on : 1995-12-05
Resolution : 2.75 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	:	2022.3.0, CSD as543be (2022)
Xtriage (Phenix)	:	NOT EXECUTED
EDS	:	NOT EXECUTED
Percentile statistics	:	20250101.v01 (using entries in the PDB archive January 1st 2025)
Ideal geometry (proteins)	:	Engh & Huber (2001)
Ideal geometry (DNA, RNA)	:	Parkinson et al. (1996)
Validation Pipeline (wwPDB-VP)	:	2.49

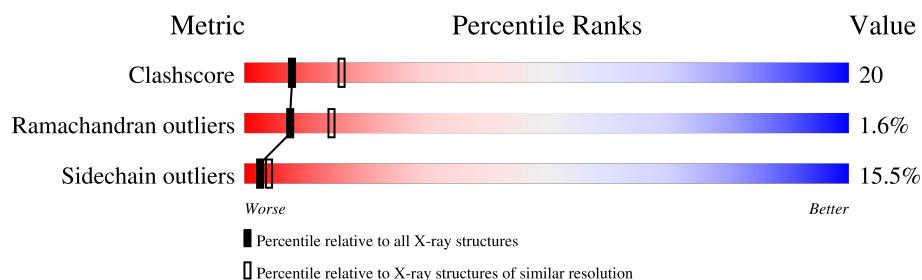
1 Overall quality at a glance

The following experimental techniques were used to determine the structure:

X-RAY DIFFRACTION

The reported resolution of this entry is 2.75 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))
Clashscore	190562	1044 (2.76-2.76)
Ramachandran outliers	187476	1024 (2.76-2.76)
Sidechain outliers	187428	1024 (2.76-2.76)

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 $\leq 5\%$.

Note EDS was not executed.

Mol	Chain	Length	Quality of chain
1	A	316	51% 38% 9% .

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	PO4	A	317	-	X	-	-

2 Entry composition [i](#)

There are 3 unique types of molecules in this entry. The entry contains 2653 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.

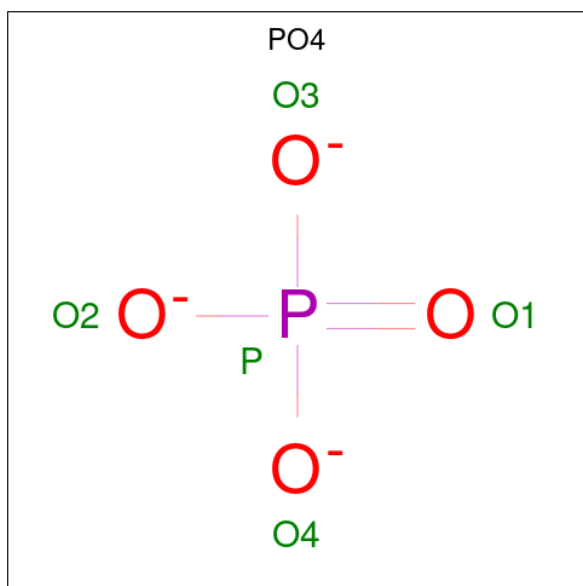
- Molecule 1 is a protein called THYMIDYLATE SYNTHASE.

Mol	Chain	Residues	Atoms					ZeroOcc	AltConf	Trace
			Total	C	N	O	S			
1	A	316	2591	1678	436	469	8	0	0	0

There is a discrepancy between the modelled and reference sequences:

Chain	Residue	Modelled	Actual	Comment	Reference
A	179	LYS	ARG	engineered mutation	UNP P00469

- Molecule 2 is PHOSPHATE ION (CCD ID: PO4) (formula: O₄P).



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

- Molecule 3 is water.

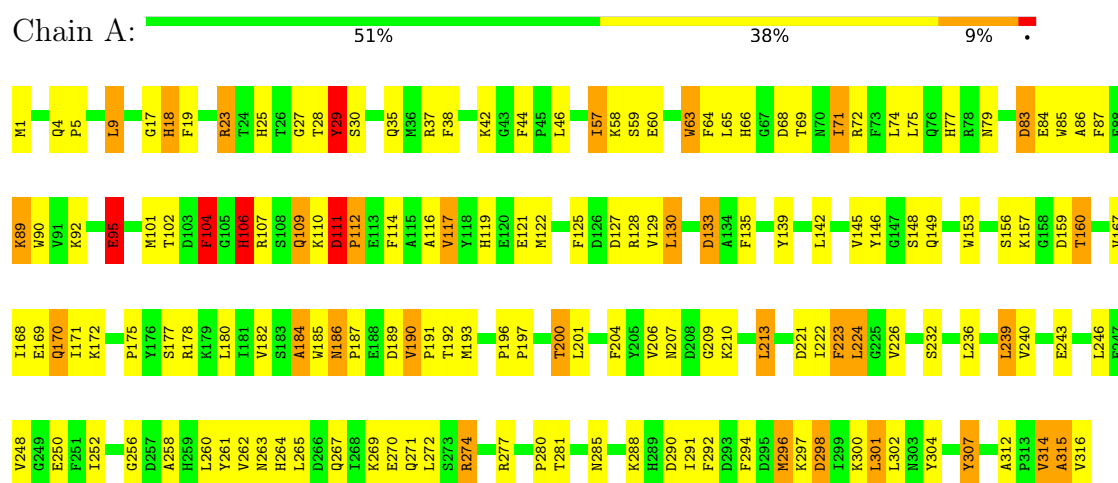
Mol	Chain	Residues	Atoms		ZeroOcc	AltConf
3	A	57	Total	O	0	0
			57	57		

3 Residue-property plots

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. 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. 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.

Note EDS was not executed.

• Molecule 1: THYMIDYLATE SYNTHASE



4 Data and refinement statistics

Xtriage (Phenix) and EDS were not executed - this section is therefore incomplete.

Property	Value	Source
Space group	P 61 2 2	Depositor
Cell constants a, b, c, α , β , γ	78.30Å 78.30Å 243.20Å 90.00° 90.00° 120.00°	Depositor
Resolution (Å)	7.00 – 2.75	Depositor
% Data completeness (in resolution range)	(Not available) (7.00-2.75)	Depositor
R_{merge}	0.23	Depositor
R_{sym}	(Not available)	Depositor
Refinement program	X-PLOR	Depositor
R, R_{free}	0.193 , (Not available)	Depositor
Estimated twinning fraction	No twinning to report.	Xtriage
Total number of atoms	2653	wwPDB-VP
Average B, all atoms (Å ²)	16.0	wwPDB-VP

5 Model quality

5.1 Standard geometry

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	0.54	0/2675	1.13	30/3635 (0.8%)

There are no bond length outliers.

All (30) bond angle outliers are listed below:

Mol	Chain	Res	Type	Atoms	Z	Observed(°)	Ideal(°)
1	A	29	TYR	N-CA-C	-8.48	95.08	108.90
1	A	224	LEU	N-CA-C	8.06	121.23	111.40
1	A	200	THR	N-CA-C	8.01	120.09	111.36
1	A	110	LYS	N-CA-C	-7.40	98.52	109.62
1	A	106	HIS	N-CA-C	-6.97	103.61	111.07
1	A	209	GLY	N-CA-C	-6.51	104.88	114.90
1	A	315	ALA	N-CA-C	6.47	120.09	111.30
1	A	83	ASP	N-CA-C	6.37	118.22	111.28
1	A	122	MET	N-CA-C	-6.26	104.54	111.36
1	A	63	TRP	N-CA-C	-5.96	104.79	111.28
1	A	256	GLY	N-CA-C	-5.61	99.89	113.18
1	A	156	SER	N-CA-C	-5.60	105.18	112.23
1	A	130	LEU	N-CA-C	5.57	118.28	111.82
1	A	307	TYR	N-CA-C	-5.43	102.25	110.39
1	A	95	GLU	N-CA-C	-5.41	105.54	111.82
1	A	133	ASP	N-CA-C	5.41	116.86	111.07
1	A	190	VAL	N-CA-C	5.37	120.48	108.88
1	A	186	ASN	CA-C-N	5.37	124.82	119.24
1	A	186	ASN	C-N-CA	5.37	124.82	119.24
1	A	18	HIS	N-CA-C	-5.36	101.43	109.95
1	A	178	ARG	N-CA-C	-5.35	106.34	112.92
1	A	223	PHE	N-CA-C	5.35	116.96	111.03
1	A	44	PHE	CA-C-N	5.33	126.50	119.84
1	A	44	PHE	C-N-CA	5.33	126.50	119.84

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Mol	Chain	Res	Type	Atoms	Z	Observed(°)	Ideal(°)
1	A	285	ASN	CA-C-N	5.31	124.94	119.05
1	A	285	ASN	C-N-CA	5.31	124.94	119.05
1	A	184	ALA	N-CA-C	-5.23	105.76	113.61
1	A	196	PRO	N-CA-C	-5.16	104.41	110.70
1	A	111	ASP	N-CA-C	5.05	119.76	109.60
1	A	296	MET	N-CA-C	5.01	117.13	111.11

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	2591	0	2498	101	0
2	A	5	0	0	0	0
3	A	57	0	0	3	0
All	All	2653	0	2498	101	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 20.

All (101) 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:59:SER:CB	1:A:296:MET:HE1	1.65	1.26
1:A:59:SER:CA	1:A:296:MET:HE1	1.87	1.04
1:A:59:SER:HB3	1:A:296:MET:HE1	1.37	1.03
1:A:59:SER:HA	1:A:296:MET:HE1	1.47	0.93
1:A:59:SER:HB3	1:A:296:MET:CE	2.00	0.92
1:A:59:SER:CB	1:A:296:MET:CE	2.51	0.85
1:A:29:TYR:HE1	1:A:262:VAL:HG22	1.47	0.78
1:A:29:TYR:CE1	1:A:262:VAL:HG22	2.26	0.69
1:A:267:GLN:HG2	1:A:312:ALA:HB2	1.74	0.69
1:A:114:PHE:O	1:A:117:VAL:HG22	1.94	0.67
1:A:86:ALA:HB2	1:A:142:LEU:HD21	1.76	0.67

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Atom-1	Atom-2	Interatomic distance (Å)	Clash overlap (Å)
1:A:301:LEU:HD13	1:A:304:TYR:HB2	1.78	0.66
1:A:71:ILE:HG22	1:A:129:VAL:HG11	1.77	0.66
1:A:59:SER:HA	1:A:296:MET:CE	2.25	0.66
1:A:224:LEU:HD11	1:A:314:VAL:HA	1.79	0.64
1:A:168:ILE:O	1:A:172:LYS:HG3	1.99	0.63
1:A:17:GLY:HA2	1:A:30:SER:O	1.99	0.62
1:A:239:LEU:O	1:A:291:ILE:HG21	2.00	0.62
1:A:274:ARG:HG2	1:A:307:TYR:CD2	2.36	0.61
1:A:28:THR:HG22	1:A:261:TYR:HA	1.83	0.61
1:A:37:ARG:HB3	1:A:252:ILE:HG13	1.84	0.60
1:A:74:LEU:HB3	1:A:79:ASN:HB3	1.83	0.60
1:A:224:LEU:HG	1:A:264:HIS:CE1	2.37	0.60
1:A:189:ASP:O	1:A:193:MET:HG3	2.02	0.59
1:A:185:TRP:HB2	1:A:200:THR:HG23	1.86	0.57
1:A:222:ILE:HD11	1:A:258:ALA:HB1	1.86	0.56
1:A:71:ILE:HD12	1:A:86:ALA:HB3	1.87	0.55
1:A:128:ARG:HB3	1:A:135:PHE:CD2	2.41	0.55
1:A:224:LEU:HG	1:A:264:HIS:HE1	1.71	0.55
1:A:145:VAL:HG12	1:A:146:TYR:H	1.73	0.54
1:A:145:VAL:HG12	1:A:146:TYR:N	2.22	0.54
1:A:84:GLU:HB3	3:A:324:HOH:O	2.08	0.53
1:A:116:ALA:O	1:A:119:HIS:HB2	2.07	0.53
1:A:265:LEU:O	1:A:269:LYS:HG2	2.08	0.53
1:A:280:PRO:HB2	1:A:301:LEU:CD2	2.39	0.53
1:A:207:ASN:HD22	1:A:207:ASN:C	2.17	0.53
1:A:90:TRP:CZ3	1:A:95:GLU:HB3	2.44	0.52
1:A:270:GLU:OE2	1:A:274:ARG:HD2	2.09	0.52
1:A:301:LEU:CD1	1:A:304:TYR:HB2	2.40	0.51
1:A:204:PHE:CZ	1:A:240:VAL:HG21	2.46	0.51
1:A:184:ALA:O	1:A:197:PRO:HG2	2.10	0.51
1:A:19:PHE:CZ	1:A:27:GLY:HA3	2.45	0.50
1:A:267:GLN:HE21	1:A:312:ALA:HA	1.76	0.50
1:A:29:TYR:OH	1:A:265:LEU:HD11	2.12	0.50
1:A:185:TRP:CE2	1:A:190:VAL:HG11	2.47	0.50
1:A:9:LEU:HD13	1:A:222:ILE:HG13	1.94	0.49
1:A:77:HIS:CD2	1:A:296:MET:HE3	2.48	0.49
1:A:106:HIS:O	1:A:109:GLN:HB2	2.14	0.48
1:A:280:PRO:HB2	1:A:301:LEU:HD21	1.96	0.47
1:A:102:THR:O	1:A:107:ARG:HD2	2.13	0.47
1:A:23:ARG:O	1:A:23:ARG:HD3	2.13	0.47
1:A:60:GLU:O	1:A:63:TRP:HB3	2.15	0.47

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Atom-1	Atom-2	Interatomic distance (Å)	Clash overlap (Å)
1:A:42:LYS:HA	1:A:42:LYS:HD3	1.73	0.47
1:A:37:ARG:HD3	1:A:250:GLU:OE2	2.15	0.46
1:A:175:PRO:O	1:A:206:VAL:HB	2.15	0.46
1:A:243:GLU:HB2	1:A:291:ILE:HG23	1.98	0.46
1:A:89:LYS:NZ	1:A:89:LYS:HB3	2.30	0.46
1:A:177:SER:HB3	1:A:180:LEU:HG	1.98	0.46
1:A:19:PHE:HZ	1:A:27:GLY:HA3	1.81	0.46
1:A:90:TRP:C	1:A:92:LYS:H	2.24	0.46
1:A:59:SER:HB2	1:A:296:MET:HE1	1.80	0.45
1:A:213:LEU:C	1:A:213:LEU:HD12	2.41	0.45
1:A:87:PHE:O	1:A:90:TRP:HB3	2.17	0.45
1:A:89:LYS:HD2	1:A:139:TYR:HD1	1.81	0.45
1:A:71:ILE:HD12	1:A:86:ALA:CB	2.47	0.45
1:A:66:HIS:HD2	1:A:292:PHE:O	2.00	0.44
1:A:125:PHE:O	1:A:128:ARG:HB2	2.17	0.44
1:A:167:VAL:HA	1:A:170:GLN:HB2	2.00	0.44
1:A:75:LEU:C	1:A:77:HIS:H	2.26	0.44
1:A:27:GLY:O	1:A:262:VAL:HG23	2.18	0.43
1:A:90:TRP:HZ3	1:A:95:GLU:HB3	1.84	0.43
1:A:66:HIS:CD2	1:A:292:PHE:O	2.72	0.43
1:A:72:ARG:NH2	1:A:133:ASP:HA	2.33	0.43
1:A:223:PHE:CD2	1:A:224:LEU:HD23	2.54	0.43
1:A:69:THR:HG21	1:A:148:SER:HB3	2.01	0.43
1:A:90:TRP:CD1	1:A:125:PHE:CD1	3.07	0.43
1:A:190:VAL:N	1:A:191:PRO:HD2	2.34	0.43
1:A:206:VAL:HG22	1:A:246:LEU:HD21	2.00	0.43
1:A:288:LYS:HD3	1:A:298:ASP:OD2	2.18	0.43
1:A:223:PHE:HE2	1:A:312:ALA:HB3	1.84	0.42
1:A:4:GLN:HB2	3:A:380:HOH:O	2.20	0.42
1:A:84:GLU:HG3	1:A:85:TRP:N	2.34	0.42
1:A:281:THR:OG1	1:A:302:LEU:HB2	2.19	0.42
1:A:315:ALA:O	1:A:316:VAL:HB	2.19	0.42
1:A:111:ASP:HA	1:A:112:PRO:HD3	1.66	0.42
1:A:63:TRP:CD1	1:A:68:ASP:HB3	2.54	0.42
1:A:153:TRP:CH2	1:A:186:ASN:HB2	2.55	0.42
1:A:187:PRO:HA	1:A:190:VAL:HG22	2.01	0.42
1:A:262:VAL:O	1:A:265:LEU:HG	2.18	0.42
1:A:167:VAL:O	1:A:171:ILE:HG13	2.20	0.42
1:A:57:ILE:HG13	1:A:58:LYS:N	2.34	0.42
1:A:46:LEU:HD12	1:A:46:LEU:HA	1.88	0.42
1:A:159:ASP:CG	1:A:160:THR:H	2.27	0.41

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Atom-1	Atom-2	Interatomic distance (Å)	Clash overlap (Å)
1:A:71:ILE:HD11	1:A:83:ASP:HA	2.02	0.41
1:A:1:MET:HB2	3:A:380:HOH:O	2.19	0.41
1:A:221:ASP:O	1:A:226:VAL:HG23	2.20	0.41
1:A:104:PHE:O	1:A:106:HIS:N	2.54	0.41
1:A:57:ILE:HD13	1:A:232:SER:HA	2.02	0.41
1:A:64:PHE:CE1	1:A:146:TYR:HB2	2.55	0.41
1:A:72:ARG:HH21	1:A:133:ASP:HA	1.85	0.41
1:A:5:PRO:HG2	1:A:38:PHE:CE2	2.56	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	314/316 (99%)	283 (90%)	26 (8%)	5 (2%)	7 14

All (5) Ramachandran outliers are listed below:

Mol	Chain	Res	Type
1	A	25	HIS
1	A	104	PHE
1	A	112	PRO
1	A	263	ASN
1	A	314	VAL

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	278/278 (100%)	235 (84%)	43 (16%)	2 4

All (43) residues with a non-rotameric sidechain are listed below:

Mol	Chain	Res	Type
1	A	9	LEU
1	A	18	HIS
1	A	23	ARG
1	A	29	TYR
1	A	35	GLN
1	A	57	ILE
1	A	65	LEU
1	A	71	ILE
1	A	89	LYS
1	A	95	GLU
1	A	101	MET
1	A	104	PHE
1	A	106	HIS
1	A	109	GLN
1	A	111	ASP
1	A	117	VAL
1	A	121	GLU
1	A	127	ASP
1	A	130	LEU
1	A	149	GLN
1	A	157	LYS
1	A	160	THR
1	A	169	GLU
1	A	170	GLN
1	A	182	VAL
1	A	192	THR
1	A	201	LEU
1	A	210	LYS
1	A	213	LEU
1	A	236	LEU
1	A	239	LEU
1	A	248	VAL
1	A	260	LEU
1	A	271	GLN
1	A	272	LEU
1	A	274	ARG

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Mol	Chain	Res	Type
1	A	277	ARG
1	A	290	ASP
1	A	294	PHE
1	A	297	LYS
1	A	298	ASP
1	A	300	LYS
1	A	301	LEU

Sometimes sidechains can be flipped to improve hydrogen bonding and reduce clashes. All (8) such sidechains are listed below:

Mol	Chain	Res	Type
1	A	4	GLN
1	A	34	HIS
1	A	35	GLN
1	A	199	HIS
1	A	207	ASN
1	A	214	GLN
1	A	229	ASN
1	A	263	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 oligosaccharides in this entry.

5.6 Ligand geometry [i](#)

1 ligand is 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	A	317	-	4,4,4	2.68	2 (50%)	6,6,6	2.29	4 (66%)

All (2) bond length outliers are listed below:

Mol	Chain	Res	Type	Atoms	Z	Observed(Å)	Ideal(Å)
2	A	317	PO4	P-O1	4.42	1.60	1.50
2	A	317	PO4	P-O2	-2.10	1.48	1.54

All (4) bond angle outliers are listed below:

Mol	Chain	Res	Type	Atoms	Z	Observed(°)	Ideal(°)
2	A	317	PO4	O4-P-O3	2.85	116.77	107.91
2	A	317	PO4	O3-P-O1	-2.63	101.66	110.95
2	A	317	PO4	O3-P-O2	2.40	115.39	107.91
2	A	317	PO4	O2-P-O1	-2.36	102.61	110.95

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

6.1 Protein, DNA and RNA chains

EDS was not executed - this section is therefore empty.

6.2 Non-standard residues in protein, DNA, RNA chains

EDS was not executed - this section is therefore empty.

6.3 Carbohydrates

EDS was not executed - this section is therefore empty.

6.4 Ligands

EDS was not executed - this section is therefore empty.

6.5 Other polymers

EDS was not executed - this section is therefore empty.