



Full wwPDB X-ray Structure Validation Report ⓘ

May 22, 2020 – 08:22 am BST

PDB ID : 3IHI
Title : Crystal structure of mouse thymidylate synthase
Authors : Dowiercial, A.; Jarmula, A.; Rypniewski, W.R.; Sokolowska, M.; Fraczyk, T.; Ciesla, J.; Rode, W.
Deposited on : 2009-07-30
Resolution : 1.94 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 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

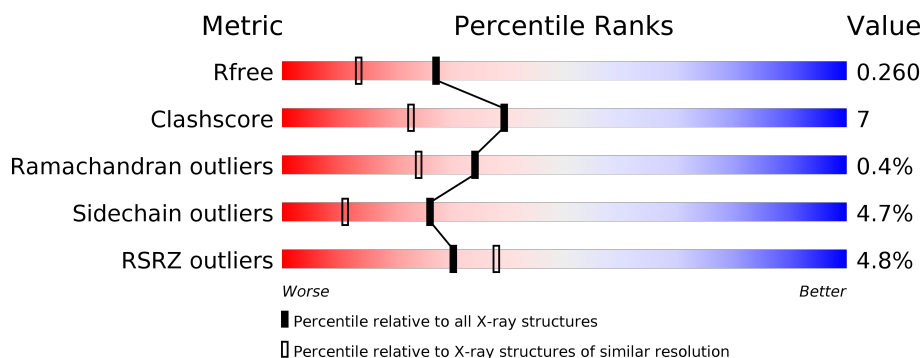
1 Overall quality at a glance

The following experimental techniques were used to determine the structure:

X-RAY DIFFRACTION

The reported resolution of this entry is 1.94 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	4310 (1.96-1.92)
Clashscore	141614	1023 (1.94-1.94)
Ramachandran outliers	138981	1007 (1.94-1.94)
Sidechain outliers	138945	1007 (1.94-1.94)
RSRZ outliers	127900	4250 (1.96-1.92)

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 ≥ 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	307	<div> <div>4%</div> <div> <div></div> <div>77%</div> <div>14%</div> <div>•</div> <div>9%</div> </div> </div>
1	B	307	<div> <div>5%</div> <div> <div></div> <div>72%</div> <div>19%</div> <div>•</div> <div>8%</div> </div> </div>

2 Entry composition [i](#)

There are 3 unique types of molecules in this entry. The entry contains 4932 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
1	A	280	Total	C	N	O	S	0	0	0
			2264	1450	393	410	11			
1	B	283	Total	C	N	O	S	0	0	0
			2289	1467	397	413	12			

- Molecule 2 is SULFATE ION (three-letter code: SO4) (formula: O₄S).



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

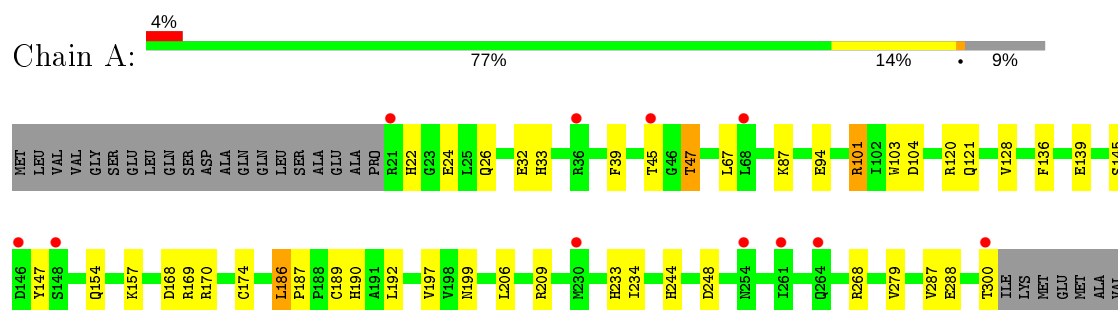
- Molecule 3 is water.

Mol	Chain	Residues	Atoms		ZeroOcc	AltConf
3	A	205	Total 205	O 205	0	0
3	B	164	Total 164	O 164	0	0

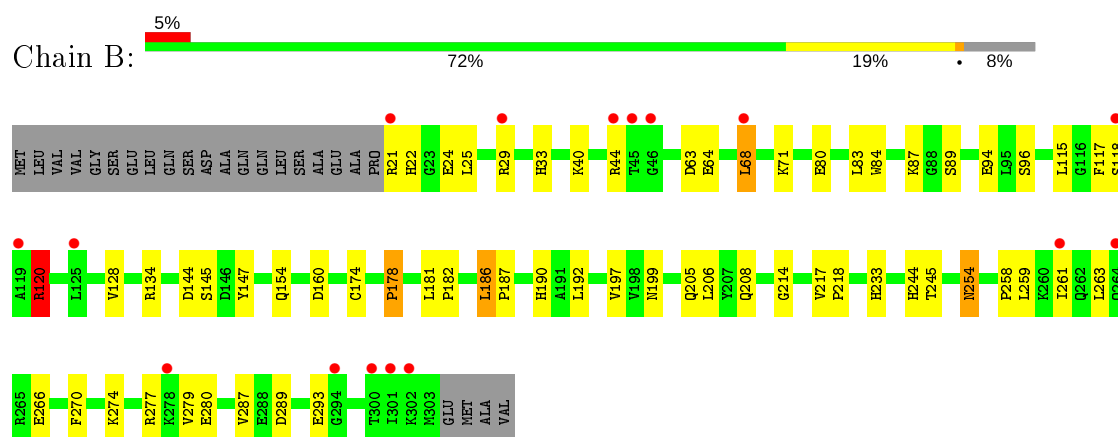
3 Residue-property plots [i](#)

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: Thymidylate synthase



• Molecule 1: Thymidylate synthase



4 Data and refinement statistics

Property	Value	Source
Space group	C 1 2 1	Depositor
Cell constants a, b, c, α , β , γ	158.20 Å 87.96 Å 68.04 Å 90.00° 97.43° 90.00°	Depositor
Resolution (Å)	19.48 – 1.94 19.05 – 1.94	Depositor EDS
% Data completeness (in resolution range)	98.5 (19.48-1.94) 98.5 (19.05-1.94)	Depositor EDS
R_{merge}	0.05	Depositor
R_{sym}	(Not available)	Depositor
$\langle I/\sigma(I) \rangle$ ¹	3.12 (at 1.94 Å)	Xtriage
Refinement program	REFMAC 5.5.0072	Depositor
R, R_{free}	0.220 , 0.266 0.221 , 0.260	Depositor DCC
R_{free} test set	1366 reflections (2.03%)	wwPDB-VP
Wilson B-factor (Å ²)	35.2	Xtriage
Anisotropy	0.140	Xtriage
Bulk solvent k_{sol} (e/Å ³), B_{sol} (Å ²)	0.39 , 52.4	EDS
L-test for twinning ²	$\langle L \rangle = 0.50$, $\langle L^2 \rangle = 0.34$	Xtriage
Estimated twinning fraction	No twinning to report.	Xtriage
F_o, F_c correlation	0.95	EDS
Total number of atoms	4932	wwPDB-VP
Average B, all atoms (Å ²)	41.0	wwPDB-VP

Xtriage's analysis on translational NCS is as follows: *The largest off-origin peak in the Patterson function is 4.23% of the height of the origin peak. No significant pseudotranslation is detected.*

¹Intensities estimated from amplitudes.

²Theoretical 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: SO4

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	1.20	3/2323 (0.1%)	0.94	5/3142 (0.2%)
1	B	1.16	2/2348 (0.1%)	0.91	7/3174 (0.2%)
All	All	1.18	5/4671 (0.1%)	0.92	12/6316 (0.2%)

All (5) bond length outliers are listed below:

Mol	Chain	Res	Type	Atoms	Z	Observed(Å)	Ideal(Å)
1	A	197	VAL	CB-CG1	6.24	1.66	1.52
1	B	197	VAL	CB-CG1	6.20	1.65	1.52
1	A	189	CYS	CB-SG	-5.99	1.72	1.81
1	B	217	VAL	CB-CG2	5.83	1.65	1.52
1	A	103	TRP	CB-CG	5.19	1.59	1.50

All (12) bond angle outliers are listed below:

Mol	Chain	Res	Type	Atoms	Z	Observed(°)	Ideal(°)
1	B	120	ARG	NE-CZ-NH2	-6.53	117.04	120.30
1	B	192	LEU	CA-CB-CG	6.31	129.82	115.30
1	B	144	ASP	CB-CG-OD1	5.65	123.39	118.30
1	A	67	LEU	CB-CG-CD2	-5.48	101.68	111.00
1	B	134	ARG	NE-CZ-NH2	5.31	122.96	120.30
1	B	160	ASP	CB-CG-OD2	-5.30	113.53	118.30
1	B	186	LEU	CA-CB-CG	5.24	127.35	115.30
1	A	209	ARG	NE-CZ-NH2	-5.22	117.69	120.30
1	A	248	ASP	CB-CG-OD1	5.21	122.99	118.30
1	B	144	ASP	CB-CG-OD2	-5.20	113.62	118.30
1	A	169	ARG	NE-CZ-NH1	5.16	122.88	120.30
1	A	120	ARG	NE-CZ-NH2	-5.02	117.79	120.30

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	2264	0	2228	34	1
1	B	2289	0	2261	35	0
2	A	5	0	0	0	0
2	B	5	0	0	0	0
3	A	205	0	0	10	0
3	B	164	0	0	7	1
All	All	4932	0	4489	67	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 7.

All (67) 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:199:ASN:HB3	3:B:339:HOH:O	1.37	1.24
1:A:45:THR:OG1	1:A:47:THR:HG22	1.44	1.13
1:B:233:HIS:HE1	1:B:279:VAL:H	1.10	0.95
1:A:22:HIS:HD2	1:A:24:GLU:H	1.19	0.90
1:B:254:ASN:HD22	1:B:254:ASN:H	1.13	0.89
1:A:45:THR:HG1	1:A:47:THR:HG22	1.34	0.86
1:A:45:THR:OG1	1:A:47:THR:CG2	2.25	0.83
1:B:120:ARG:HD2	3:B:424:HOH:O	1.80	0.82
1:B:22:HIS:HD2	1:B:24:GLU:H	1.29	0.81
1:A:233:HIS:HE1	1:A:279:VAL:H	1.30	0.79
1:A:101:ARG:HG3	1:A:104:ASP:OD2	1.85	0.77
1:A:233:HIS:HD2	3:A:487:HOH:O	1.68	0.75
1:B:94:GLU:OE1	3:B:451:HOH:O	2.07	0.71
1:A:192:LEU:C	1:A:192:LEU:HD12	2.12	0.70
1:A:121:GLN:OE1	3:A:378:HOH:O	2.09	0.70
1:B:68:LEU:HD22	1:B:218:PRO:HB3	1.74	0.69
1:A:190:HIS:HD2	3:A:308:HOH:O	1.74	0.68
1:A:22:HIS:HE1	1:A:268:ARG:O	1.77	0.68

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Atom-1	Atom-2	Interatomic distance (Å)	Clash overlap (Å)
1:A:154:GLN:HE22	1:A:174:CYS:H	1.40	0.67
1:A:26:GLN:OE1	3:A:325:HOH:O	2.12	0.67
1:B:154:GLN:HE22	1:B:174:CYS:H	1.42	0.67
1:A:288:GLU:CG	3:A:311:HOH:O	2.43	0.66
1:B:254:ASN:H	1:B:254:ASN:ND2	1.92	0.65
1:A:87:LYS:HE3	1:A:94:GLU:OE2	1.97	0.65
1:B:274:LYS:HE3	1:B:293:GLU:OE1	1.97	0.63
1:A:154:GLN:NE2	1:A:174:CYS:H	1.98	0.62
1:A:22:HIS:CD2	1:A:24:GLU:H	2.09	0.60
1:B:233:HIS:CE1	1:B:279:VAL:H	2.03	0.60
1:A:288:GLU:HG3	3:A:311:HOH:O	2.03	0.58
1:B:244:HIS:HD2	3:B:325:HOH:O	1.87	0.57
1:A:244:HIS:HD2	3:A:310:HOH:O	1.88	0.56
1:B:87:LYS:HE3	1:B:94:GLU:OE2	2.05	0.56
1:B:33:HIS:HD2	3:B:461:HOH:O	1.88	0.56
1:B:258:PRO:HA	1:B:261:ILE:HD12	1.89	0.55
1:B:154:GLN:NE2	1:B:174:CYS:H	2.05	0.54
1:B:71:LYS:NZ	1:B:214:GLY:O	2.41	0.53
1:B:254:ASN:HD22	1:B:254:ASN:N	1.93	0.52
1:A:190:HIS:HB3	1:A:206:LEU:HD11	1.92	0.52
1:B:64:GLU:OE2	1:B:270:PHE:HD2	1.92	0.52
1:A:136:PHE:CZ	1:B:178:PRO:HD2	2.46	0.51
1:A:233:HIS:CE1	1:A:279:VAL:H	2.21	0.49
1:B:208:GLN:OE1	1:B:244:HIS:HE1	1.96	0.48
1:B:145:SER:HB2	1:B:147:TYR:CZ	2.49	0.48
1:A:145:SER:HB2	1:A:147:TYR:CZ	2.48	0.48
1:A:192:LEU:O	1:A:192:LEU:HD12	2.13	0.48
1:B:181:LEU:HD22	1:B:187:PRO:HB3	1.95	0.47
1:A:288:GLU:OE2	3:A:311:HOH:O	2.21	0.46
1:A:186:LEU:HD23	1:A:187:PRO:HD2	1.97	0.45
1:B:33:HIS:HE1	3:B:422:HOH:O	1.98	0.45
1:B:277:ARG:HH11	1:B:289:ASP:CG	2.19	0.45
1:B:117:PHE:HZ	1:B:182:PRO:O	1.99	0.45
1:B:205:GLN:NE2	1:B:245:THR:OG1	2.46	0.45
1:B:84:TRP:CD1	1:B:89:SER:HB3	2.51	0.44
1:A:168:ASP:OD2	1:A:170:ARG:HB2	2.17	0.44
1:B:190:HIS:HB3	1:B:206:LEU:HD11	2.00	0.44
1:B:80:GLU:OE2	1:B:287:VAL:HG21	2.18	0.44
1:A:157:LYS:NZ	1:A:157:LYS:HB2	2.33	0.43
1:A:192:LEU:C	1:A:192:LEU:CD1	2.83	0.43
1:A:233:HIS:HE1	1:A:279:VAL:N	2.07	0.43

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Atom-1	Atom-2	Interatomic distance (Å)	Clash overlap (Å)
1:A:47:THR:CG2	3:A:426:HOH:O	2.66	0.43
1:B:199:ASN:CB	3:B:339:HOH:O	2.20	0.42
1:B:25:LEU:O	1:B:29:ARG:HB2	2.20	0.41
1:A:39:PHE:CD2	1:B:199:ASN:ND2	2.77	0.41
1:B:259:LEU:O	1:B:263:LEU:HG	2.20	0.41
1:A:22:HIS:CE1	1:A:268:ARG:O	2.65	0.41
1:B:181:LEU:N	1:B:182:PRO:CD	2.84	0.41
1:A:33:HIS:HD2	3:A:485:HOH:O	2.05	0.40

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)
1:A:199:ASN:ND2	3:B:339:HOH:O[4_646]	2.13	0.07

5.3 Torsion angles

5.3.1 Protein backbone

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	278/307 (91%)	270 (97%)	7 (2%)	1 (0%)	34	24
1	B	281/307 (92%)	267 (95%)	13 (5%)	1 (0%)	34	24
All	All	559/614 (91%)	537 (96%)	20 (4%)	2 (0%)	34	24

All (2) Ramachandran outliers are listed below:

Mol	Chain	Res	Type
1	A	128	VAL
1	B	128	VAL

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	244/266 (92%)	236 (97%)	8 (3%)	38	24
1	B	247/266 (93%)	232 (94%)	15 (6%)	18	6
All	All	491/532 (92%)	468 (95%)	23 (5%)	26	11

All (23) residues with a non-rotameric sidechain are listed below:

Mol	Chain	Res	Type
1	A	32	GLU
1	A	47	THR
1	A	101	ARG
1	A	139	GLU
1	A	186	LEU
1	A	234	ILE
1	A	287	VAL
1	A	300	THR
1	B	21	ARG
1	B	40	LYS
1	B	44	ARG
1	B	63	ASP
1	B	68	LEU
1	B	83	LEU
1	B	96	SER
1	B	115	LEU
1	B	118	SER
1	B	120	ARG
1	B	178	PRO
1	B	186	LEU
1	B	254	ASN
1	B	266	GLU
1	B	280	GLU

Some sidechains can be flipped to improve hydrogen bonding and reduce clashes. All (19) such sidechains are listed below:

Mol	Chain	Res	Type
1	A	22	HIS
1	A	30	GLN
1	A	56	GLN
1	A	154	GLN
1	A	156	GLN
1	A	194	GLN
1	A	205	GLN
1	A	233	HIS
1	A	244	HIS
1	B	22	HIS
1	B	56	GLN
1	B	154	GLN
1	B	194	GLN
1	B	205	GLN
1	B	233	HIS
1	B	244	HIS
1	B	254	ASN
1	B	264	GLN
1	B	296	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](#)

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	SO4	A	501	-	4,4,4	0.50	0	6,6,6	0.80	0
2	SO4	B	501	-	4,4,4	0.62	0	6,6,6	0.95	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.

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 ⓘ

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, 95th 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	A	280/307 (91%)	0.12	11 (3%) 39 47	24, 37, 55, 64	0
1	B	283/307 (92%)	0.35	16 (5%) 23 30	25, 41, 62, 84	0
All	All	563/614 (91%)	0.23	27 (4%) 30 38	24, 38, 59, 84	0

All (27) RSRZ outliers are listed below:

Mol	Chain	Res	Type	RSRZ
1	B	46	GLY	7.0
1	B	21	ARG	5.5
1	A	300	THR	5.2
1	B	302	LYS	4.9
1	B	45	THR	4.2
1	A	148	SER	4.0
1	A	21	ARG	4.0
1	A	261	ILE	3.8
1	B	264	GLN	3.7
1	A	45	THR	3.6
1	B	261	ILE	3.4
1	A	264	GLN	3.3
1	B	301	ILE	3.1
1	A	254	ASN	2.9
1	B	278	LYS	2.8
1	B	68	LEU	2.8
1	B	119	ALA	2.7
1	B	300	THR	2.6
1	A	36	ARG	2.4
1	A	146	ASP	2.4
1	B	118	SER	2.4
1	A	68	LEU	2.3
1	B	294	GLY	2.3
1	B	125	LEU	2.2

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Mol	Chain	Res	Type	RSRZ
1	A	230	MET	2.1
1	B	29	ARG	2.0
1	B	44	ARG	2.0

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, 95th 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(\AA^2)	Q<0.9
2	SO4	A	501	5/5	0.98	0.09	47,53,55,58	0
2	SO4	B	501	5/5	0.99	0.12	43,45,55,57	0

6.5 Other polymers [i](#)

There are no such residues in this entry.