



Full wwPDB X-ray Structure Validation Report ⓘ

Oct 10, 2021 – 04:20 PM EDT

PDB ID : 3GH2
Title : Replacement of Val3 in Human Thymidylate Synthase Affects Its Kinetic Properties and Intracellular Stability
Authors : Huang, X.; Gibson, L.M.; Bell, B.J.; Lovelace, L.L.; Lebioda, L.
Deposited on : 2009-03-02
Resolution : 1.75 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 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 : 2.23.2
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) : 2.23.2

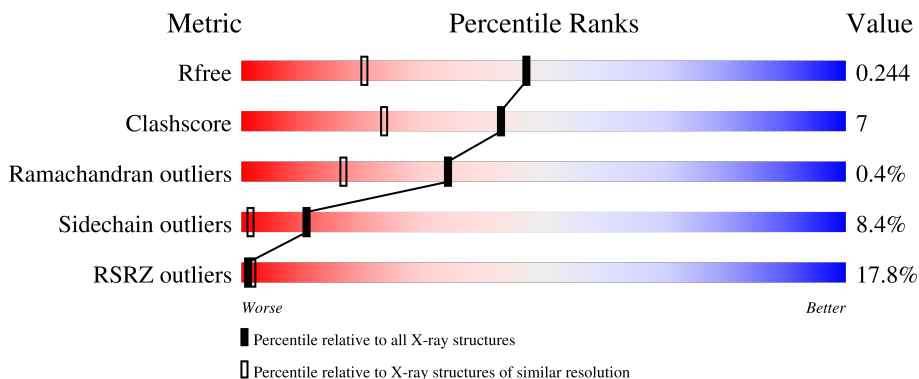
1 Overall quality at a glance

The following experimental techniques were used to determine the structure:

X-RAY DIFFRACTION

The reported resolution of this entry is 1.75 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))
R_{free}	130704	2340 (1.76-1.76)
Clashscore	141614	2466 (1.76-1.76)
Ramachandran outliers	138981	2437 (1.76-1.76)
Sidechain outliers	138945	2437 (1.76-1.76)
RSRZ outliers	127900	2298 (1.76-1.76)

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 $\leq 5\%$. 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	X	313	

2 Entry composition [i](#)

There are 3 unique types of molecules in this entry. The entry contains 2350 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	X	276	2234	1429	389	403	13	0	0	0

There is a discrepancy between the modelled and reference sequences:

Chain	Residue	Modelled	Actual	Comment	Reference
X	3	PHE	VAL	engineered mutation	UNP P04818

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



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

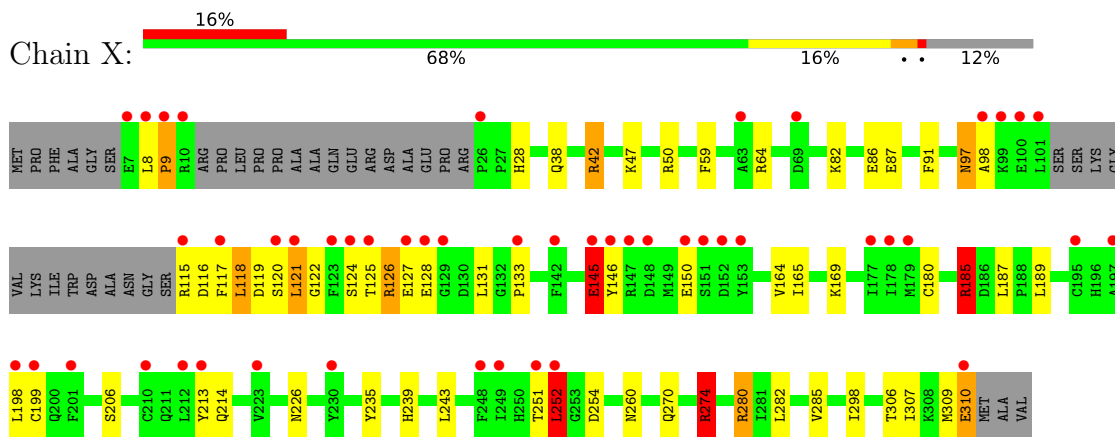
- Molecule 3 is water.

Mol	Chain	Residues	Atoms		ZeroOcc	AltConf
3	X	101	Total 101	O 101	0	0

3 Residue-property plots [i](#)

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 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



4 Data and refinement statistics i

Property	Value	Source
Space group	P 31 2 1	Depositor
Cell constants a, b, c, α , β , γ	96.02Å 96.02Å 80.72Å 90.00° 90.00° 120.00°	Depositor
Resolution (Å)	50.00 – 1.75 41.26 – 1.75	Depositor EDS
% Data completeness (in resolution range)	85.9 (50.00-1.75) 85.9 (41.26-1.75)	Depositor EDS
R_{merge}	0.08	Depositor
R_{sym}	(Not available)	Depositor
$\langle I/\sigma(I) \rangle$ ¹	1.33 (at 1.75Å)	Xtrriage
Refinement program	REFMAC	Depositor
R, R_{free}	0.218 , 0.254 0.209 , 0.244	Depositor DCC
R_{free} test set	1885 reflections (5.02%)	wwPDB-VP
Wilson B-factor (Å ²)	32.8	Xtrriage
Anisotropy	0.733	Xtrriage
Bulk solvent k_{sol} (e/Å ³), B_{sol} (Å ²)	0.35 , 57.4	EDS
L-test for twinning ²	$\langle L \rangle = 0.50$, $\langle L^2 \rangle = 0.33$	Xtrriage
Estimated twinning fraction	0.033 for -h,-k,l	Xtrriage
F_o, F_c correlation	0.96	EDS
Total number of atoms	2350	wwPDB-VP
Average B, all atoms (Å ²)	48.0	wwPDB-VP

Xtrriage's analysis on translational NCS is as follows: *The largest off-origin peak in the Patterson function is 4.16% 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 i

5.1 Standard geometry i

Bond lengths and bond angles in the following residue types are not validated in this section: SO4, CME

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	X	1.26	14/2279 (0.6%)	1.15	8/3079 (0.3%)

All (14) bond length outliers are listed below:

Mol	Chain	Res	Type	Atoms	Z	Observed(Å)	Ideal(Å)
1	X	199	CYS	CB-SG	-9.73	1.65	1.82
1	X	235	TYR	CG-CD2	6.61	1.47	1.39
1	X	164	VAL	CB-CG2	6.54	1.66	1.52
1	X	252	LEU	N-CA	-6.37	1.33	1.46
1	X	59	PHE	CE1-CZ	6.10	1.49	1.37
1	X	270	GLN	CG-CD	6.10	1.65	1.51
1	X	251	THR	CB-CG2	5.85	1.71	1.52
1	X	91	PHE	CE1-CZ	5.74	1.48	1.37
1	X	213	TYR	CD1-CE1	5.72	1.48	1.39
1	X	213	TYR	CE1-CZ	-5.58	1.31	1.38
1	X	145	GLU	CG-CD	5.53	1.60	1.51
1	X	64	ARG	CG-CD	5.49	1.65	1.51
1	X	59	PHE	CG-CD2	5.28	1.46	1.38
1	X	87	GLU	CG-CD	5.12	1.59	1.51

All (8) bond angle outliers are listed below:

Mol	Chain	Res	Type	Atoms	Z	Observed(°)	Ideal(°)
1	X	274	ARG	NE-CZ-NH2	9.77	125.18	120.30
1	X	274	ARG	NE-CZ-NH1	-9.49	115.56	120.30
1	X	9	PRO	N-CA-CB	8.20	113.14	103.30
1	X	260	ASN	CB-CA-C	-7.12	96.16	110.40
1	X	185	ARG	NE-CZ-NH1	6.38	123.49	120.30
1	X	252	LEU	CA-CB-CG	6.17	129.48	115.30
1	X	213	TYR	CB-CG-CD2	-5.58	117.65	121.00

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Mol	Chain	Res	Type	Atoms	Z	Observed(°)	Ideal(°)
1	X	199	CYS	N-CA-CB	-5.17	101.29	110.60

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	X	2234	0	2190	30	0
2	X	15	0	0	0	0
3	X	101	0	0	1	0
All	All	2350	0	2190	30	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 7.

All (30) 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:X:239:HIS:HE1	1:X:285:VAL:H	1.21	0.88
1:X:280:ARG:HB2	1:X:280:ARG:HH21	1.41	0.86
1:X:122:GLY:O	1:X:126:ARG:HG3	1.99	0.63
1:X:239:HIS:CE1	1:X:285:VAL:H	2.12	0.60
1:X:145:GLU:H	1:X:145:GLU:CD	2.10	0.55
1:X:50:ARG:HD2	1:X:185:ARG:CZ	2.37	0.54
1:X:38:GLN:O	1:X:42:ARG:HG3	2.08	0.53
1:X:309:MET:O	1:X:310:GLU:C	2.46	0.53
1:X:124:SER:O	1:X:127:GLU:HB2	2.09	0.52
1:X:50:ARG:HD2	1:X:185:ARG:NH2	2.25	0.51
1:X:165:ILE:O	1:X:169:LYS:HG3	2.11	0.51
1:X:280:ARG:HG2	1:X:282:LEU:HD23	1.95	0.49
1:X:28:HIS:NE2	1:X:274:ARG:O	2.45	0.48
1:X:116:ASP:O	1:X:119:ASP:HB2	2.16	0.46
1:X:125:THR:O	1:X:128:GLU:HG2	2.16	0.46
1:X:145:GLU:CD	1:X:145:GLU:N	2.69	0.46

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Atom-1	Atom-2	Interatomic distance (Å)	Clash overlap (Å)
1:X:133:PRO:HG3	1:X:146:TYR:HB2	1.98	0.46
1:X:214:GLN:HB2	1:X:252:LEU:HD12	1.98	0.46
1:X:118:LEU:HA	1:X:121:LEU:HD22	1.98	0.45
1:X:97:ASN:HD22	1:X:97:ASN:C	2.20	0.45
1:X:280:ARG:HH21	1:X:280:ARG:CB	2.23	0.44
1:X:118:LEU:HB3	1:X:126:ARG:NH2	2.33	0.43
1:X:306:THR:HG22	1:X:307:ILE:N	2.32	0.43
1:X:47:LYS:NZ	1:X:254:ASP:OD2	2.48	0.43
1:X:206:SER:HA	1:X:243:LEU:HD22	1.99	0.43
1:X:98:ALA:HB2	1:X:131:LEU:HD11	2.00	0.42
1:X:187:LEU:HD23	1:X:187:LEU:HA	1.78	0.42
1:X:309:MET:O	3:X:398:HOH:O	2.22	0.41
1:X:118:LEU:HD12	1:X:121:LEU:CD2	2.51	0.41
1:X:8:LEU:HA	1:X:226:ASN:HD21	1.86	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	X	269/313 (86%)	256 (95%)	12 (4%)	1 (0%)	34 17

All (1) Ramachandran outliers are listed below:

Mol	Chain	Res	Type
1	X	9	PRO

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	X	238/270 (88%)	218 (92%)	20 (8%)	11 1

All (20) residues with a non-rotameric sidechain are listed below:

Mol	Chain	Res	Type
1	X	42	ARG
1	X	82	LYS
1	X	86	GLU
1	X	97	ASN
1	X	115	ARG
1	X	117	PHE
1	X	118	LEU
1	X	120	SER
1	X	121	LEU
1	X	126	ARG
1	X	145	GLU
1	X	150	GLU
1	X	185	ARG
1	X	189	LEU
1	X	198	LEU
1	X	252	LEU
1	X	274	ARG
1	X	280	ARG
1	X	298	ILE
1	X	310	GLU

Sometimes sidechains can be flipped to improve hydrogen bonding and reduce clashes. All (4) such sidechains are listed below:

Mol	Chain	Res	Type
1	X	97	ASN
1	X	171	ASN
1	X	226	ASN
1	X	239	HIS

5.3.3 RNA

There are no RNA molecules in this entry.

5.4 Non-standard residues in protein, DNA, RNA chains [i](#)

1 non-standard protein/DNA/RNA residue 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
1	CME	X	180	1	8,9,10	0.90	0	5,9,11	1.35	1 (20%)

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
1	CME	X	180	1	-	2/5/8/10	-

There are no bond length outliers.

All (1) bond angle outliers are listed below:

Mol	Chain	Res	Type	Atoms	Z	Observed(°)	Ideal(°)
1	X	180	CME	CB-SG-SD	2.06	109.16	103.82

There are no chirality outliers.

All (2) torsion outliers are listed below:

Mol	Chain	Res	Type	Atoms
1	X	180	CME	SD-CE-CZ-OH
1	X	180	CME	CZ-CE-SD-SG

There are no ring outliers.

No monomer is involved in short contacts.

5.5 Carbohydrates [i](#)

There are no monosaccharides in this entry.

5.6 Ligand geometry [i](#)

3 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	X	318	-	4,4,4	0.41	0	6,6,6	1.15	1 (16%)
2	SO4	X	315	-	4,4,4	0.33	0	6,6,6	0.84	0
2	SO4	X	317	-	4,4,4	0.48	0	6,6,6	1.18	0

There are no bond length outliers.

All (1) bond angle outliers are listed below:

Mol	Chain	Res	Type	Atoms	Z	Observed(°)	Ideal(°)
2	X	318	SO4	O3-S-O2	-2.08	98.47	109.31

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	X	275/313 (87%)	0.90	49 (17%) 1 2	31, 43, 72, 106	0

All (49) RSRZ outliers are listed below:

Mol	Chain	Res	Type	RSRZ
1	X	8	LEU	14.7
1	X	123	PHE	7.9
1	X	9	PRO	5.6
1	X	99	LYS	5.6
1	X	124	SER	5.1
1	X	199	CYS	4.4
1	X	195	CYS	4.3
1	X	128	GLU	4.1
1	X	213	TYR	4.1
1	X	150	GLU	4.0
1	X	153	TYR	4.0
1	X	178	ILE	3.9
1	X	115	ARG	3.8
1	X	146	TYR	3.8
1	X	152	ASP	3.7
1	X	210	CYS	3.7
1	X	147	ARG	3.7
1	X	198	LEU	3.6
1	X	133	PRO	3.6
1	X	201	PHE	3.5
1	X	249	ILE	3.5
1	X	148	ASP	3.5
1	X	26	PRO	3.3
1	X	7	GLU	3.2
1	X	101	LEU	3.2
1	X	212	LEU	3.2
1	X	125	THR	3.1

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Mol	Chain	Res	Type	RSRZ
1	X	145	GLU	3.0
1	X	121	LEU	2.9
1	X	151	SER	2.8
1	X	117	PHE	2.8
1	X	120	SER	2.7
1	X	127	GLU	2.6
1	X	100	GLU	2.6
1	X	129	GLY	2.6
1	X	197	ALA	2.5
1	X	310	GLU	2.5
1	X	177	ILE	2.4
1	X	251	THR	2.3
1	X	252	LEU	2.3
1	X	10	ARG	2.3
1	X	98	ALA	2.3
1	X	69	ASP	2.2
1	X	63	ALA	2.2
1	X	223	VAL	2.1
1	X	230	TYR	2.1
1	X	142	PHE	2.1
1	X	179	MET	2.0
1	X	248	PHE	2.0

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, 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(Å ²)	Q<0.9
1	CME	X	180	10/11	0.95	0.17	40,43,73,75	0

6.3 Carbohydrates [i](#)

There are no monosaccharides 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(Å ²)	Q<0.9
2	SO4	X	315	5/5	0.92	0.21	79,81,82,82	0
2	SO4	X	317	5/5	0.97	0.07	56,60,63,64	0
2	SO4	X	318	5/5	0.99	0.05	53,55,56,58	0

6.5 Other polymers [i](#)

There are no such residues in this entry.