



Full wwPDB X-ray Structure Validation Report ⓘ

Mar 9, 2026 – 04:36 AM UTC

PDB ID : 1BKP / pdb_00001bkp
Title : THERMOSTABLE THYMIDYLATE SYNTHASE A FROM BACILLUS SUBTILIS
Authors : Stout, T.J.; Schellenberger, U.; Santi, D.V.; Stroud, R.M.
Deposited on : 1998-07-09
Resolution : 1.70 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
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

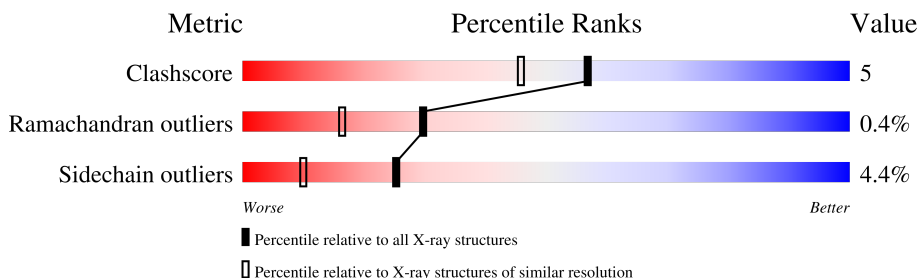
1 Overall quality at a glance

The following experimental techniques were used to determine the structure:

X-RAY DIFFRACTION

The reported resolution of this entry is 1.70 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	5924 (1.70-1.70)
Ramachandran outliers	187476	5846 (1.70-1.70)
Sidechain outliers	187428	5846 (1.70-1.70)

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	278	
1	B	278	

2 Entry composition

There are 2 unique types of molecules in this entry. The entry contains 4963 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 A.

Mol	Chain	Residues	Atoms					ZeroOcc	AltConf	Trace
1	A	278	Total	C	N	O	S	0	1	0
			2307	1474	391	431	11			
1	B	278	Total	C	N	O	S	6	0	0
			2307	1474	393	430	10			

- Molecule 2 is water.

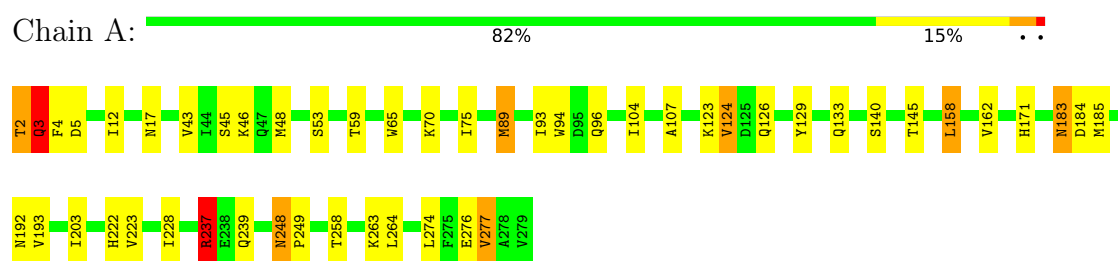
Mol	Chain	Residues	Atoms		ZeroOcc	AltConf
2	A	177	Total	O	0	0
			177	177		
2	B	172	Total	O	0	0
			172	172		

3 Residue-property plots

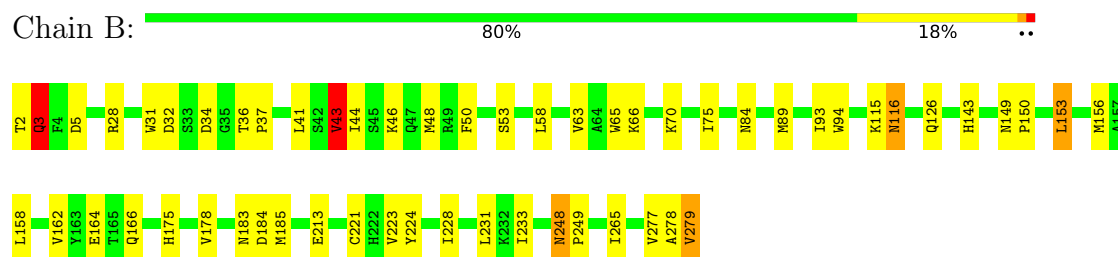
These plots are drawn for all protein, RNA, DNA and oligosaccharide chains in the entry. The first graphic for a chain summarises the proportions of the various outlier classes displayed in the second graphic. The second graphic shows the sequence view annotated by issues in geometry. Residues are color-coded 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 A



• Molecule 1: THYMIDYLATE SYNTHASE A



4 Data and refinement statistics

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

Property	Value	Source
Space group	P 1 21 1	Depositor
Cell constants a, b, c, α , β , γ	59.94Å 81.63Å 64.79Å 90.00° 92.52° 90.00°	Depositor
Resolution (Å)	48.30 – 1.70	Depositor
% Data completeness (in resolution range)	88.9 (48.30-1.70)	Depositor
R_{merge}	0.09	Depositor
R_{sym}	0.09	Depositor
Refinement program	X-PLOR 3.843	Depositor
R, R_{free}	0.151 , 0.206	Depositor
Estimated twinning fraction	No twinning to report.	Xtriage
Total number of atoms	4963	wwPDB-VP
Average B, all atoms (Å ²)	25.0	wwPDB-VP

5 Model quality [i](#)

5.1 Standard geometry [i](#)

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	1.45	12/2365 (0.5%)	1.34	22/3204 (0.7%)
1	B	1.42	10/2365 (0.4%)	1.31	14/3203 (0.4%)
All	All	1.44	22/4730 (0.5%)	1.33	36/6407 (0.6%)

All (22) bond length outliers are listed below:

Mol	Chain	Res	Type	Atoms	Z	Observed(Å)	Ideal(Å)
1	B	44	ILE	CA-CB	8.68	1.65	1.54
1	B	233	ILE	CA-CB	8.19	1.64	1.54
1	A	203	ILE	CA-CB	8.10	1.64	1.54
1	A	12	ILE	CA-CB	6.31	1.62	1.54
1	A	3	GLN	CB-CG	6.31	1.71	1.52
1	A	48	MET	SD-CE	-6.15	1.64	1.79
1	B	156	MET	SD-CE	6.07	1.94	1.79
1	A	3	GLN	N-CA	-5.94	1.38	1.46
1	B	75	ILE	CA-C	5.81	1.60	1.52
1	B	162	VAL	CA-CB	5.76	1.59	1.53
1	B	48	MET	SD-CE	-5.58	1.65	1.79
1	B	63	VAL	N-CA	5.58	1.52	1.46
1	A	59	THR	CA-CB	-5.35	1.45	1.54
1	B	149	ASN	C-O	-5.30	1.17	1.24
1	A	104	ILE	CA-CB	5.27	1.60	1.54
1	A	193	VAL	CA-CB	-5.23	1.48	1.54
1	A	162	VAL	CA-CB	5.21	1.59	1.53
1	B	41	LEU	CA-C	5.17	1.58	1.52
1	A	107	ALA	CA-CB	-5.13	1.46	1.53
1	A	239	GLN	CA-C	5.13	1.58	1.52
1	A	258	THR	CA-CB	5.07	1.62	1.53
1	B	115	LYS	CA-C	-5.02	1.46	1.52

All (36) bond angle outliers are listed below:

Mol	Chain	Res	Type	Atoms	Z	Observed(°)	Ideal(°)
1	A	237	ARG	NE-CZ-NH1	9.37	130.87	121.50
1	B	3	GLN	N-CA-C	9.32	130.66	110.80
1	A	237	ARG	NE-CZ-NH2	-8.15	111.86	119.20
1	B	248	ASN	CA-C-N	7.89	127.53	119.56
1	B	248	ASN	C-N-CA	7.89	127.53	119.56
1	B	53	SER	N-CA-C	-7.52	104.08	113.18
1	A	4	PHE	N-CA-C	-7.04	103.65	111.82
1	A	124	VAL	N-CA-CB	-6.99	99.43	112.36
1	A	17	ASN	N-CA-C	6.93	120.97	112.23
1	A	184	ASP	N-CA-C	-6.56	98.50	108.67
1	A	65	TRP	N-CA-C	6.29	118.14	111.28
1	A	145	THR	N-CA-C	-6.22	100.01	109.85
1	A	228	ILE	N-CA-C	6.20	116.38	110.42
1	B	65	TRP	N-CA-C	6.12	117.95	111.28
1	B	228	ILE	N-CA-C	6.10	116.84	110.62
1	B	3	GLN	CA-C-O	5.99	129.07	120.51
1	A	258	THR	N-CA-C	-5.97	100.25	109.14
1	A	123	LYS	N-CA-C	-5.65	100.03	109.24
1	A	124	VAL	CG1-CB-CG2	5.52	122.94	110.80
1	A	248	ASN	CA-C-N	5.45	125.12	119.56
1	A	248	ASN	C-N-CA	5.45	125.12	119.56
1	A	3	GLN	CA-C-O	5.42	128.26	120.51
1	A	140	SER	N-CA-C	5.41	117.87	110.24
1	B	41	LEU	N-CA-C	-5.35	100.98	109.59
1	B	34	ASP	N-CA-C	5.31	121.58	113.19
1	A	75	ILE	N-CA-C	5.28	115.49	110.53
1	B	43	VAL	CB-CA-C	5.27	119.21	110.30
1	B	162	VAL	N-CA-C	-5.27	99.09	107.15
1	B	43	VAL	CG1-CB-CG2	5.23	122.31	110.80
1	B	184	ASP	N-CA-C	-5.23	100.56	108.67
1	A	53	SER	N-CA-C	-5.21	106.43	112.89
1	A	277	VAL	CB-CA-C	-5.17	104.43	111.15
1	A	237	ARG	CD-NE-CZ	5.06	131.48	124.40
1	A	222	HIS	N-CA-C	5.05	117.48	109.50
1	A	89	MET	N-CA-C	-5.03	106.73	112.92
1	B	164	GLU	N-CA-C	5.01	116.69	109.07

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	2307	0	2230	17	0
1	B	2307	0	2237	25	0
2	A	177	0	0	2	0
2	B	172	0	0	9	0
All	All	4963	0	4467	42	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 5.

All (42) 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:2:THR:HG21	2:B:559:HOH:O	1.78	0.83
1:B:46:LYS:HE2	2:B:543:HOH:O	1.82	0.79
1:A:3:GLN:HE21	1:A:5:ASP:H	1.43	0.67
1:A:93:ILE:HG13	1:A:94:TRP:CD1	2.30	0.66
1:B:175:HIS:CD2	1:B:213:GLU:H	2.18	0.62
1:B:93:ILE:HG13	1:B:94:TRP:CD1	2.41	0.56
1:A:2:THR:O	1:A:3:GLN:C	2.50	0.55
1:B:126:GLN:HG3	2:B:484:HOH:O	2.06	0.55
1:B:3:GLN:NE2	2:B:657:HOH:O	2.39	0.54
1:B:2:THR:HG22	1:B:50:PHE:HD2	1.73	0.53
1:A:158:LEU:H	1:A:158:LEU:HD12	1.75	0.52
1:A:183:ASN:HD21	1:A:192:ASN:HD22	1.57	0.51
1:A:276:GLU:H	1:A:276:GLU:CD	2.19	0.50
1:B:175:HIS:HD2	1:B:213:GLU:H	1.60	0.50
1:A:70:LYS:HG2	1:A:89:MET:HE2	1.94	0.50
1:B:185:MET:HB2	1:B:223:VAL:HG12	1.93	0.49
1:A:158:LEU:HD12	1:A:158:LEU:N	2.28	0.49
1:B:32:ASP:OD1	1:B:277:VAL:HB	2.13	0.48
1:B:278:ALA:O	1:B:279:VAL:C	2.55	0.48
1:A:237:ARG:HD2	2:A:595:HOH:O	2.12	0.48
1:B:3:GLN:HG3	1:B:5:ASP:H	1.79	0.47
1:A:126:GLN:HG3	2:A:429:HOH:O	2.15	0.46
1:B:70:LYS:HG2	1:B:89:MET:HE2	1.96	0.46

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Atom-1	Atom-2	Interatomic distance (Å)	Clash overlap (Å)
1:A:93:ILE:HG13	1:A:94:TRP:HD1	1.77	0.46
1:B:150:PRO:HA	1:B:153:LEU:HD22	1.99	0.45
1:A:171:HIS:HE1	2:B:507:HOH:O	2.00	0.45
1:B:175:HIS:HE1	2:B:663:HOH:O	2.01	0.44
1:B:116:ASN:HD22	1:B:116:ASN:C	2.26	0.44
1:B:31:TRP:CH2	1:B:224:TYR:HB3	2.53	0.44
1:B:36:THR:HB	1:B:37:PRO:HD2	2.00	0.43
1:B:43:VAL:HG12	1:B:221:CYS:HB2	2.00	0.43
1:B:248:ASN:HA	1:B:249:PRO:HD3	1.74	0.43
1:B:143:HIS:HD2	2:B:623:HOH:O	2.02	0.43
1:A:185:MET:HB2	1:A:223:VAL:HG12	2.01	0.42
1:A:43:VAL:HG21	1:A:46:LYS:HE3	2.01	0.42
1:B:3:GLN:HG3	1:B:5:ASP:N	2.33	0.42
1:A:129:TYR:CE2	1:A:133:GLN:HG3	2.56	0.41
1:A:248:ASN:HA	1:A:249:PRO:HD3	1.88	0.41
1:B:84:ASN:HB3	2:B:578:HOH:O	2.20	0.41
1:A:264:LEU:HD12	1:A:264:LEU:HA	1.93	0.40
1:B:3:GLN:CD	2:B:657:HOH:O	2.64	0.40
1:B:143:HIS:O	1:B:166:GLN:HA	2.22	0.40

There are no symmetry-related clashes.

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	277/278 (100%)	270 (98%)	6 (2%)	1 (0%)	30	16
1	B	276/278 (99%)	269 (98%)	6 (2%)	1 (0%)	30	16
All	All	553/556 (100%)	539 (98%)	12 (2%)	2 (0%)	30	16

All (2) Ramachandran outliers are listed below:

Mol	Chain	Res	Type
1	B	3	GLN
1	A	45	SER

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	253/253 (100%)	243 (96%)	10 (4%)	28	12
1	B	253/253 (100%)	241 (95%)	12 (5%)	23	9
All	All	506/506 (100%)	484 (96%)	22 (4%)	25	10

All (22) residues with a non-rotameric sidechain are listed below:

Mol	Chain	Res	Type
1	A	2	THR
1	A	3	GLN
1	A	96	GLN
1	A	124	VAL
1	A	158	LEU
1	A	183	ASN
1	A	237	ARG
1	A	263	LYS
1	A	274	LEU
1	A	277	VAL
1	B	28	ARG
1	B	43	VAL
1	B	58	LEU
1	B	66	LYS
1	B	116	ASN
1	B	153	LEU
1	B	158	LEU
1	B	178	VAL
1	B	183	ASN
1	B	231	LEU
1	B	265	ILE
1	B	279	VAL

Sometimes sidechains can be flipped to improve hydrogen bonding and reduce clashes. All (26) such sidechains are listed below:

Mol	Chain	Res	Type
1	A	3	GLN
1	A	39	HIS
1	A	87	ASN
1	A	96	GLN
1	A	133	GLN
1	A	136	ASN
1	A	137	ASN
1	A	183	ASN
1	A	189	ASN
1	A	222	HIS
1	A	234	GLN
1	B	17	ASN
1	B	39	HIS
1	B	84	ASN
1	B	99	GLN
1	B	116	ASN
1	B	120	ASN
1	B	132	HIS
1	B	133	GLN
1	B	137	ASN
1	B	143	HIS
1	B	171	HIS
1	B	175	HIS
1	B	183	ASN
1	B	189	ASN
1	B	192	ASN

5.3.3 RNA ⓘ

There are no RNA molecules in this entry.

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

There are no non-standard protein/DNA/RNA residues in this entry.

5.5 Carbohydrates ⓘ

There are no oligosaccharides in this entry.

5.6 Ligand geometry

There are no ligands in this entry.

5.7 Other polymers

There are no such residues in this entry.

5.8 Polymer linkage issues

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.