



Full wwPDB X-ray Structure Validation Report ⓘ

Mar 9, 2026 – 09:51 AM UTC

PDB ID : 2ST1 / pdb_00002st1
Title : THE THREE-DIMENSIONAL STRUCTURE OF BACILLUS AMYLOLIQUEFACIENS SUBTILISIN AT 1.8 ANGSTROMS AND AN ANALYSIS OF THE STRUCTURAL CONSEQUENCES OF PEROXIDE INACTIVATION
Authors : Bott, R.
Deposited on : 1990-05-11
Resolution : 1.80 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

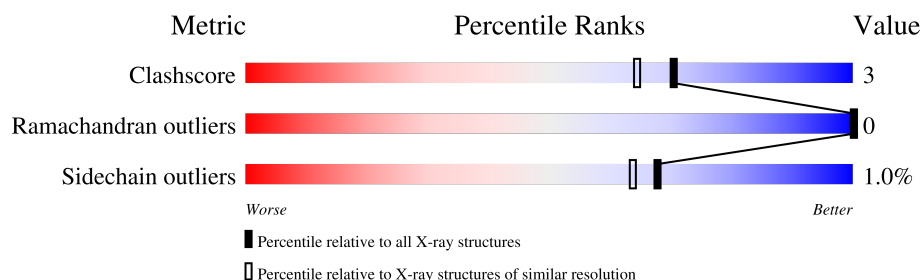
1 Overall quality at a glance

The following experimental techniques were used to determine the structure:

X-RAY DIFFRACTION

The reported resolution of this entry is 1.80 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	8479 (1.80-1.80)
Ramachandran outliers	187476	8391 (1.80-1.80)
Sidechain outliers	187428	8390 (1.80-1.80)

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	275	

2 Entry composition [i](#)

There are 4 unique types of molecules in this entry. The entry contains 2099 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.

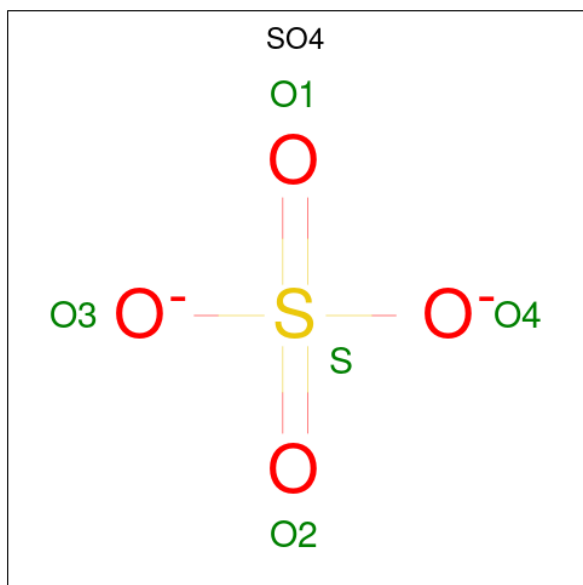
- Molecule 1 is a protein called SUBTILISIN BPN'.

Mol	Chain	Residues	Atoms					ZeroOcc	AltConf	Trace
1	A	275	Total	C	N	O	S	0	0	0
			1938	1204	335	394	5			

- Molecule 2 is CALCIUM ION (CCD ID: CA) (formula: Ca).

Mol	Chain	Residues	Atoms		ZeroOcc	AltConf
2	A	2	Total	Ca	0	0
			2	2		

- Molecule 3 is SULFATE ION (CCD ID: SO4) (formula: O₄S).



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

- Molecule 4 is water.

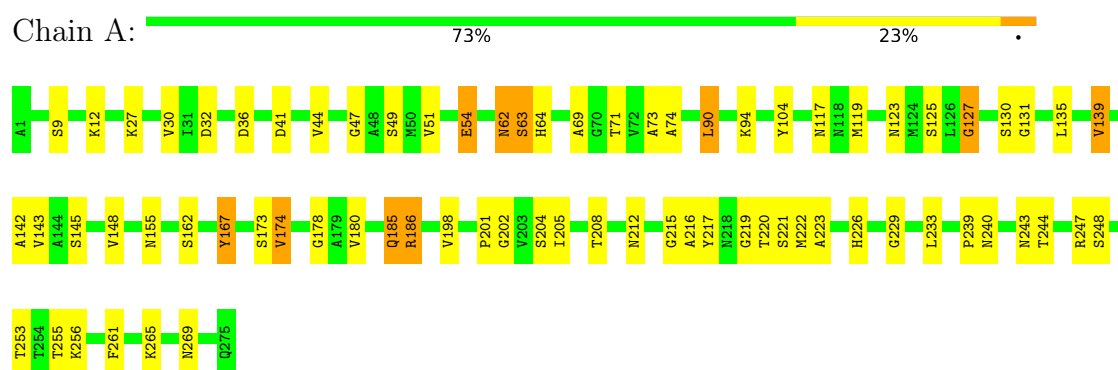
Mol	Chain	Residues	Atoms		ZeroOcc	AltConf
4	A	154	Total 154	O 154	0	0

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: SUBTILISIN BPN'



4 Data and refinement statistics

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

Property	Value	Source
Space group	P 21 21 21	Depositor
Cell constants a, b, c, α , β , γ	39.25Å 72.86Å 75.20Å 90.00° 90.00° 90.00°	Depositor
Resolution (Å)	10.00 – 1.80	Depositor
% Data completeness (in resolution range)	(Not available) (10.00-1.80)	Depositor
R_{merge}	(Not available)	Depositor
R_{sym}	(Not available)	Depositor
Refinement program	PROLSQ	Depositor
R, R_{free}	0.144 , (Not available)	Depositor
Estimated twinning fraction	No twinning to report.	Xtriage
Total number of atoms	2099	wwPDB-VP
Average B, all atoms (Å ²)	11.0	wwPDB-VP

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: CA, 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	1.30	4/1976 (0.2%)	2.16	80/2697 (3.0%)

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	A	0	1

All (4) bond length outliers are listed below:

Mol	Chain	Res	Type	Atoms	Z	Observed(Å)	Ideal(Å)
1	A	208	THR	CA-CB	5.99	1.62	1.53
1	A	131	GLY	N-CA	5.56	1.50	1.44
1	A	178	GLY	N-CA	5.14	1.50	1.44
1	A	219	GLY	N-CA	5.01	1.50	1.45

All (80) bond angle outliers are listed below:

Mol	Chain	Res	Type	Atoms	Z	Observed(°)	Ideal(°)
1	A	247	ARG	NE-CZ-NH1	-8.64	112.86	121.50
1	A	9	SER	O-C-N	8.57	131.92	122.15
1	A	32	ASP	N-CA-CB	-8.32	101.03	109.51
1	A	62	ASN	CA-C-O	-8.23	110.16	118.97
1	A	74	ALA	O-C-N	-8.17	113.26	123.06
1	A	212	ASN	OD1-CG-ND2	-8.08	114.52	122.60
1	A	269	ASN	OD1-CG-ND2	-7.99	114.61	122.60
1	A	63	SER	CA-CB-OG	-7.84	95.41	111.10
1	A	244	THR	O-C-N	7.66	129.96	122.07

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Mol	Chain	Res	Type	Atoms	Z	Observed(°)	Ideal(°)
1	A	208	THR	O-C-N	-7.47	113.74	122.93
1	A	155	ASN	OD1-CG-ND2	-7.30	115.30	122.60
1	A	174	VAL	O-C-N	7.27	130.54	122.98
1	A	233	LEU	O-C-N	7.14	130.30	122.15
1	A	90	LEU	N-CA-CB	-7.13	98.19	110.17
1	A	51	VAL	O-C-N	7.12	125.85	121.37
1	A	185	GLN	CB-CA-C	6.92	121.19	109.50
1	A	54	GLU	CG-CD-OE2	-6.89	102.56	118.40
1	A	265	LYS	CA-CB-CG	-6.71	100.68	114.10
1	A	223	ALA	CA-C-O	6.65	127.55	120.70
1	A	71	THR	CA-CB-OG1	-6.64	99.64	109.60
1	A	139	VAL	O-C-N	6.54	128.57	121.83
1	A	186	ARG	NE-CZ-NH1	6.44	127.94	121.50
1	A	255	THR	CA-CB-OG1	-6.42	99.98	109.60
1	A	73	ALA	N-CA-C	6.24	120.20	112.03
1	A	167	TYR	CA-C-O	-6.18	114.44	120.19
1	A	201	PRO	CA-C-O	-6.16	114.32	121.34
1	A	135	LEU	O-C-N	-6.12	115.77	122.07
1	A	217	TYR	O-C-N	6.12	131.10	123.15
1	A	51	VAL	N-CA-C	-6.08	101.53	107.55
1	A	41	ASP	CA-CB-CG	-6.02	106.58	112.60
1	A	47	GLY	CA-C-O	-6.01	115.70	121.83
1	A	130	SER	CA-C-N	-6.00	116.12	122.30
1	A	130	SER	C-N-CA	-6.00	116.12	122.30
1	A	131	GLY	N-CA-C	-5.98	103.14	112.58
1	A	145	SER	CA-C-O	-5.95	111.50	119.11
1	A	243	ASN	CA-CB-CG	5.83	118.43	112.60
1	A	226	HIS	O-C-N	5.76	128.22	122.12
1	A	117	ASN	CB-CG-ND2	5.75	125.02	116.40
1	A	248	SER	O-C-N	5.74	127.98	122.07
1	A	49	SER	CA-C-O	-5.73	114.63	120.71
1	A	142	ALA	O-C-N	5.67	127.92	122.07
1	A	220	THR	N-CA-C	-5.65	105.65	112.54
1	A	90	LEU	CA-C-O	-5.62	114.13	120.43
1	A	261	PHE	CA-CB-CG	5.59	119.39	113.80
1	A	198	VAL	CA-CB-CG1	5.55	119.84	110.40
1	A	30	VAL	CA-C-O	-5.53	114.57	121.04
1	A	123	ASN	OD1-CG-ND2	-5.52	117.08	122.60
1	A	12	LYS	CA-C-N	5.51	126.97	120.09
1	A	12	LYS	C-N-CA	5.51	126.97	120.09
1	A	256	LYS	O-C-N	5.51	129.61	122.89
1	A	244	THR	CA-C-O	-5.48	115.06	120.82

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Mol	Chain	Res	Type	Atoms	Z	Observed(°)	Ideal(°)
1	A	215	GLY	CA-C-N	-5.39	114.20	122.87
1	A	215	GLY	C-N-CA	-5.39	114.20	122.87
1	A	135	LEU	CA-C-O	5.37	126.46	120.82
1	A	240	ASN	CB-CG-ND2	-5.37	108.35	116.40
1	A	74	ALA	CB-CA-C	5.36	117.89	109.84
1	A	54	GLU	OE1-CD-OE2	5.36	135.76	122.90
1	A	253	THR	O-C-N	5.35	128.94	122.20
1	A	202	GLY	CA-C-N	-5.31	116.04	123.10
1	A	202	GLY	C-N-CA	-5.31	116.04	123.10
1	A	27	LYS	CB-CG-CD	-5.28	99.17	111.30
1	A	9	SER	CA-C-O	-5.23	114.87	120.42
1	A	185	GLN	CB-CG-CD	-5.23	103.71	112.60
1	A	180	VAL	O-C-N	5.22	128.56	122.97
1	A	212	ASN	O-C-N	5.21	129.00	122.55
1	A	44	VAL	CB-CA-C	5.20	117.91	110.84
1	A	239	PRO	O-C-N	5.14	129.29	122.30
1	A	148	VAL	O-C-N	-5.13	116.69	122.94
1	A	51	VAL	CA-C-N	5.09	124.88	119.28
1	A	51	VAL	C-N-CA	5.09	124.88	119.28
1	A	36	ASP	O-C-N	-5.08	115.83	122.59
1	A	73	ALA	N-CA-CB	-5.04	102.60	111.42
1	A	204	SER	O-C-N	-5.03	116.67	122.86
1	A	36	ASP	CB-CA-C	5.03	120.42	110.42
1	A	127	GLY	O-C-N	5.02	128.43	123.76
1	A	226	HIS	CB-CG-CD2	-5.02	124.67	131.20
1	A	229	GLY	O-C-N	5.02	127.01	122.19
1	A	119	MET	CA-C-N	5.02	129.16	120.58
1	A	119	MET	C-N-CA	5.02	129.16	120.58
1	A	244	THR	CA-CB-OG1	-5.00	102.09	109.60

There are no chirality outliers.

All (1) planarity outliers are listed below:

Mol	Chain	Res	Type	Group
1	A	186	ARG	Sidechain

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	1938	0	1899	13	0
2	A	2	0	0	0	0
3	A	5	0	0	0	0
4	A	154	0	0	0	0
All	All	2099	0	1899	13	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 3.

All (13) 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:125:SER:HB3	1:A:221:SER:HB3	1.52	0.91
1:A:139:VAL:HG11	1:A:174:VAL:CG2	2.24	0.66
1:A:62:ASN:O	1:A:63:SER:HB2	2.01	0.60
1:A:143:VAL:HG21	1:A:173:SER:HB2	1.86	0.57
1:A:127:GLY:HA2	1:A:167:TYR:O	2.09	0.52
1:A:125:SER:HB3	1:A:221:SER:CB	2.34	0.51
1:A:54:GLU:OE1	1:A:94:LYS:NZ	2.37	0.50
1:A:205:ILE:HG13	1:A:222:MET:HB3	1.96	0.47
1:A:205:ILE:O	1:A:216:ALA:HA	2.17	0.45
1:A:139:VAL:HG11	1:A:174:VAL:HG22	1.98	0.44
1:A:69:ALA:HB1	1:A:90:LEU:HD21	2.01	0.43
1:A:104:TYR:HD2	1:A:104:TYR:HA	1.57	0.41
1:A:62:ASN:OD1	1:A:64:HIS:HB2	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	273/275 (99%)	262 (96%)	11 (4%)	0	100	100

There are no Ramachandran outliers to report.

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	205/205 (100%)	203 (99%)	2 (1%)	68	64

All (2) residues with a non-rotameric sidechain are listed below:

Mol	Chain	Res	Type
1	A	162	SER
1	A	185	GLN

Sometimes sidechains can be flipped to improve hydrogen bonding and reduce clashes. All (5) such sidechains are listed below:

Mol	Chain	Res	Type
1	A	25	ASN
1	A	59	GLN
1	A	206	GLN
1	A	245	GLN
1	A	271	GLN

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 [i](#)

There are no oligosaccharides in this entry.

5.6 Ligand geometry [i](#)

Of 3 ligands modelled in this entry, 2 are monoatomic - leaving 1 for Mogul analysis.

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	$\# Z > 2$
3	SO4	A	278	-	4,4,4	0.79	0	6,6,6	1.21	2 (33%)

There are no bond length outliers.

All (2) bond angle outliers are listed below:

Mol	Chain	Res	Type	Atoms	Z	Observed($^{\circ}$)	Ideal($^{\circ}$)
3	A	278	SO4	O4-S-O1	2.12	120.63	109.56
3	A	278	SO4	O3-S-O1	-2.03	98.96	109.56

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.