



Full wwPDB X-ray Structure Validation Report ⓘ

Mar 5, 2026 – 04:07 PM UTC

PDB ID : 3CO0 / pdb_00003co0
Title : Substrate Complex of Fluoride-sensitive Engineered Subtilisin
SUBT_BACAM
Authors : Gallagher, D.T.; Bryan, P.N.
Deposited on : 2008-03-26
Resolution : 1.93 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) : 2.0
EDS : 3.0
Percentile statistics : 20250101.v01 (using entries in the PDB archive January 1st 2025)
CCP4 : 9.0.010 (Gargrove)
Density-Fitness : 1.0.12
Ideal geometry (proteins) : Engh & Huber (2001)
Ideal geometry (DNA, RNA) : Parkinson et al. (1996)
Validation Pipeline (wwPDB-VP) : 2.49

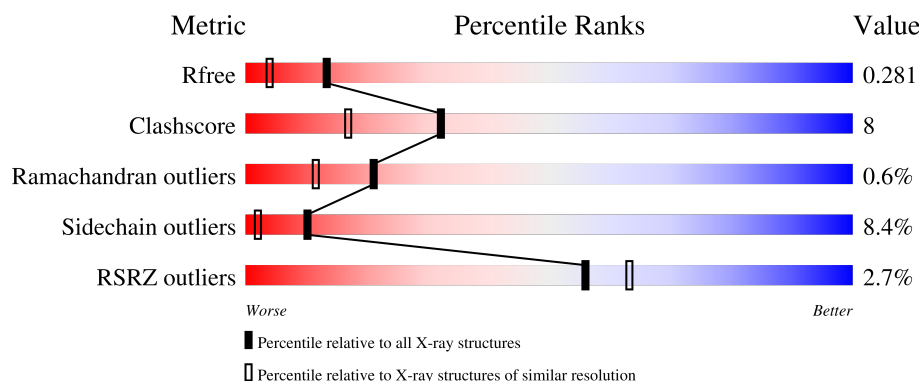
1 Overall quality at a glance

The following experimental techniques were used to determine the structure:

X-RAY DIFFRACTION

The reported resolution of this entry is 1.93 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}	180053	1452 (1.94-1.94)
Clashscore	190562	1494 (1.94-1.94)
Ramachandran outliers	187476	1479 (1.94-1.94)
Sidechain outliers	187428	1479 (1.94-1.94)
RSRZ outliers	180081	1453 (1.94-1.94)

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	P	80	72% 14% • 11%
2	S	266	3% 80% 15% • • •

2 Entry composition

There are 4 unique types of molecules in this entry. The entry contains 2674 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	P	71	Total	C	N	O	S	0	0	0
			558	357	91	108	2			

There are 22 discrepancies between the modelled and reference sequences:

Chain	Residue	Modelled	Actual	Comment	Reference
P	2	MET	-	expression tag	UNP P00782
P	3	GLY	-	expression tag	UNP P00782
P	19	GLY	THR	SEE REMARK 999	UNP P00782
P	20	PHE	MET	SEE REMARK 999	UNP P00782
P	21	LYS	SER	SEE REMARK 999	UNP P00782
P	22	SER	THR	SEE REMARK 999	UNP P00782
P	23	CYS	MET	SEE REMARK 999	UNP P00782
P	?	-	SER	SEE REMARK 999	UNP P00782
P	?	-	ALA	SEE REMARK 999	UNP P00782
P	27	GLU	LYS	engineered mutation	UNP P00782
P	37	LEU	VAL	engineered mutation	UNP P00782
P	40	CYS	GLN	engineered mutation	UNP P00782
P	57	GLU	LYS	engineered mutation	UNP P00782
P	72	LYS	HIS	engineered mutation	UNP P00782
P	73	LEU	VAL	engineered mutation	UNP P00782
P	74	TYR	ALA	engineered mutation	UNP P00782
P	75	ARG	HIS	engineered mutation	UNP P00782
P	77	LEU	TYR	engineered mutation	UNP P00782
P	78	SER	-	expression tag	UNP P00782
P	79	ALA	-	expression tag	UNP P00782
P	80	THR	-	expression tag	UNP P00782
P	81	SER	-	expression tag	UNP P00782

- Molecule 2 is a protein called Subtilisin BPN'.

Mol	Chain	Residues	Atoms					ZeroOcc	AltConf	Trace
2	S	263	Total	C	N	O	S	0	0	0
			1835	1145	316	370	4			

There are 31 discrepancies between the modelled and reference sequences:

Chain	Residue	Modelled	Actual	Comment	Reference
S	2	LYS	GLN	engineered mutation	UNP P00782
S	3	CYS	SER	engineered mutation	UNP P00782
S	5	SER	PRO	engineered mutation	UNP P00782
S	9	ALA	SER	engineered mutation	UNP P00782
S	31	LEU	ILE	engineered mutation	UNP P00782
S	32	ALA	ASP	engineered mutation	UNP P00782
S	43	ASN	LYS	engineered mutation	UNP P00782
S	50	PHE	MET	engineered mutation	UNP P00782
S	?	-	VAL	deletion	UNP P00782
S	?	-	ALA	deletion	UNP P00782
S	?	-	ALA	deletion	UNP P00782
S	?	-	LEU	deletion	UNP P00782
S	?	-	ASN	deletion	UNP P00782
S	?	-	ASN	deletion	UNP P00782
S	?	-	SER	deletion	UNP P00782
S	?	-	ILE	deletion	UNP P00782
S	?	-	GLY	deletion	UNP P00782
S	74	ALA	GLY	engineered mutation	UNP P00782
S	104	ALA	TYR	engineered mutation	UNP P00782
S	128	SER	GLY	engineered mutation	UNP P00782
S	156	SER	GLU	engineered mutation	UNP P00782
S	166	SER	GLY	engineered mutation	UNP P00782
S	169	ALA	GLY	engineered mutation	UNP P00782
S	188	PRO	SER	engineered mutation	UNP P00782
S	206	CYS	GLN	engineered mutation	UNP P00782
S	212	GLY	ASN	engineered mutation	UNP P00782
S	217	LEU	TYR	engineered mutation	UNP P00782
S	218	SER	ASN	engineered mutation	UNP P00782
S	221	ALA	SER	engineered mutation	UNP P00782
S	254	ALA	THR	engineered mutation	UNP P00782
S	271	GLU	GLN	engineered mutation	UNP P00782

- Molecule 3 is ZINC ION (CCD ID: ZN) (formula: Zn).

Mol	Chain	Residues	Atoms		ZeroOcc	AltConf
3	S	4	Total	Zn	0	0
			4	4		

- Molecule 4 is water.

Mol	Chain	Residues	Atoms		ZeroOcc	AltConf
4	P	62	Total 62	O 62	0	0
4	S	215	Total 215	O 215	0	0

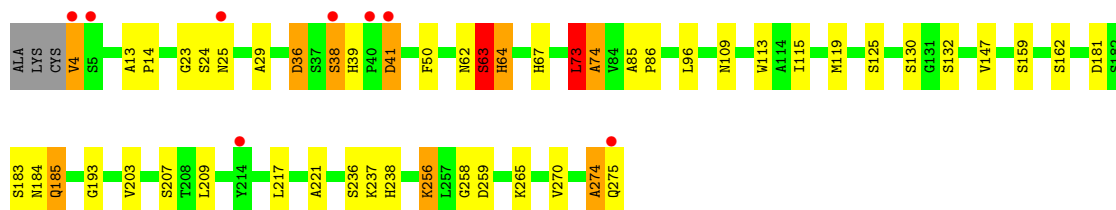
3 Residue-property plots [i](#)

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: Subtilisin BPN'



- Molecule 2: Subtilisin BPN'



4 Data and refinement statistics

Property	Value	Source
Space group	P 21 21 21	Depositor
Cell constants a, b, c, α , β , γ	44.46Å 73.06Å 95.35Å 90.00° 90.00° 90.00°	Depositor
Resolution (Å)	8.00 – 1.93 8.00 – 1.93	Depositor EDS
% Data completeness (in resolution range)	99.6 (8.00-1.93) 97.9 (8.00-1.93)	Depositor EDS
R_{merge}	0.06	Depositor
R_{sym}	(Not available)	Depositor
$\langle I/\sigma(I) \rangle$ ¹	2.13 (at 1.80Å)	Xtriage
Refinement program	REFMAC 5.2.0019	Depositor
R, R_{free}	0.230 , 0.289 0.228 , 0.281	Depositor DCC
R_{free} test set	1485 reflections (5.03%)	wwPDB-VP
Wilson B-factor (Å ²)	24.3	Xtriage
Anisotropy	0.576	Xtriage
Bulk solvent k_{sol} (e/Å ³), B_{sol} (Å ²)	0.48 , 58.8	EDS
L-test for twinning ²	$\langle L \rangle = 0.48$, $\langle L^2 \rangle = 0.31$	Xtriage
Estimated twinning fraction	No twinning to report.	Xtriage
F_o, F_c correlation	0.92	EDS
Total number of atoms	2674	wwPDB-VP
Average B, all atoms (Å ²)	17.0	wwPDB-VP

Xtriage's analysis on translational NCS is as follows: *The largest off-origin peak in the Patterson function is 5.11% 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: ZN

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	P	0.98	0/565	1.00	0/751
2	S	1.21	6/1872 (0.3%)	1.19	10/2560 (0.4%)
All	All	1.16	6/2437 (0.2%)	1.15	10/3311 (0.3%)

All (6) bond length outliers are listed below:

Mol	Chain	Res	Type	Atoms	Z	Observed(Å)	Ideal(Å)
2	S	74	ALA	C-N	16.95	1.55	1.33
2	S	274	ALA	CA-C	10.30	1.64	1.53
2	S	115	ILE	CA-CB	6.04	1.61	1.54
2	S	275	GLN	N-CA	5.41	1.56	1.46
2	S	147	VAL	CA-CB	5.20	1.60	1.54
2	S	275	GLN	CA-C	5.17	1.63	1.52

All (10) bond angle outliers are listed below:

Mol	Chain	Res	Type	Atoms	Z	Observed(°)	Ideal(°)
2	S	274	ALA	N-CA-C	13.16	128.26	109.71
2	S	73	LEU	N-CA-C	6.57	118.44	111.28
2	S	85	ALA	CA-C-N	6.54	127.06	119.47
2	S	85	ALA	C-N-CA	6.54	127.06	119.47
2	S	74	ALA	O-C-N	-6.22	115.53	122.12
2	S	275	GLN	N-CA-C	5.57	126.59	111.00
2	S	274	ALA	CA-C-O	-5.46	115.19	122.51
2	S	39	HIS	CB-CA-C	5.17	115.87	108.68
2	S	193	GLY	CA-C-N	5.01	124.79	119.28
2	S	193	GLY	C-N-CA	5.01	124.79	119.28

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	P	558	0	573	8	1
2	S	1835	0	1802	30	0
3	S	4	0	0	0	0
4	P	62	0	0	1	0
4	S	215	0	0	4	1
All	All	2674	0	2375	38	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 8.

All (38) 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)
2:S:62:ASN:O	2:S:63:SER:HB3	1.72	0.89
2:S:36:ASP:OD2	2:S:38:SER:HB2	1.83	0.77
2:S:181:ASP:HA	2:S:203:VAL:HG12	1.66	0.76
1:P:50:THR:C	1:P:51:LEU:HD12	2.14	0.72
2:S:64:HIS:HE1	2:S:96:LEU:HD12	1.58	0.69
2:S:181:ASP:HA	2:S:203:VAL:CG1	2.24	0.67
2:S:183:SER:HB2	2:S:185:GLN:HG3	1.78	0.65
2:S:113:TRP:HA	4:S:629:HOH:O	2.00	0.60
2:S:73:LEU:HD11	4:S:313:HOH:O	2.02	0.58
2:S:181:ASP:HB3	2:S:203:VAL:HG11	1.87	0.56
2:S:64:HIS:CE1	2:S:96:LEU:HD12	2.39	0.56
1:P:53:GLU:O	1:P:57:GLU:HG3	2.06	0.55
2:S:265:LYS:HE3	4:S:573:HOH:O	2.07	0.55
1:P:51:LEU:HD12	1:P:51:LEU:N	2.20	0.55
2:S:256:LYS:HD3	2:S:258:GLY:H	1.72	0.54
1:P:49:ALA:HB3	1:P:51:LEU:HD11	1.92	0.52
2:S:237:LYS:NZ	2:S:274:ALA:O	2.43	0.51
2:S:73:LEU:HD13	2:S:86:PRO:HA	1.92	0.50
2:S:13:ALA:HA	2:S:270:VAL:HG11	1.92	0.50
2:S:13:ALA:HA	2:S:270:VAL:CG1	2.44	0.48
2:S:238:HIS:HE2	2:S:274:ALA:C	2.22	0.47
2:S:181:ASP:CB	2:S:203:VAL:HG11	2.44	0.47

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Atom-1	Atom-2	Interatomic distance (Å)	Clash overlap (Å)
2:S:4:VAL:CG1	2:S:74:ALA:HB1	2.45	0.46
1:P:39:LYS:HD2	4:P:382:HOH:O	2.14	0.46
2:S:181:ASP:OD1	2:S:185:GLN:HG3	2.16	0.46
2:S:209:LEU:HD21	4:S:517:HOH:O	2.16	0.45
2:S:50:PHE:CD1	2:S:109:ASN:HB3	2.52	0.45
2:S:183:SER:O	2:S:184:ASN:HB2	2.17	0.45
1:P:72:LYS:HB2	1:P:72:LYS:HE2	1.63	0.44
2:S:13:ALA:N	2:S:14:PRO:CD	2.82	0.43
2:S:159:SER:HG	2:S:162:SER:HB2	1.84	0.43
2:S:125:SER:HB3	2:S:221:ALA:HB1	1.99	0.43
2:S:29:ALA:HB2	2:S:119:MET:HG3	2.00	0.42
1:P:12:TYR:CD1	1:P:51:LEU:HD13	2.56	0.41
2:S:23:GLY:HA2	2:S:236:SER:HB3	2.02	0.40
2:S:67:HIS:CD2	2:S:207:SER:HB3	2.56	0.40
1:P:12:TYR:HD1	1:P:51:LEU:HD13	1.86	0.40
2:S:183:SER:HB2	2:S:185:GLN:CG	2.48	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:P:45:ASP:OD2	4:S:403:HOH:O[4_445]	2.08	0.12

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	P	69/80 (86%)	67 (97%)	2 (3%)	0	100	100
2	S	261/266 (98%)	248 (95%)	11 (4%)	2 (1%)	16	7
All	All	330/346 (95%)	315 (96%)	13 (4%)	2 (1%)	21	11

All (2) Ramachandran outliers are listed below:

Mol	Chain	Res	Type
2	S	41	ASP
2	S	63	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	P	59/65 (91%)	53 (90%)	6 (10%)	7	1
2	S	192/195 (98%)	177 (92%)	15 (8%)	11	3
All	All	251/260 (96%)	230 (92%)	21 (8%)	10	2

All (21) residues with a non-rotameric sidechain are listed below:

Mol	Chain	Res	Type
1	P	10	LYS
1	P	21	LYS
1	P	32	GLU
1	P	51	LEU
1	P	72	LYS
1	P	73	LEU
2	S	4	VAL
2	S	24	SER
2	S	25	ASN
2	S	36	ASP
2	S	38	SER
2	S	41	ASP
2	S	63	SER
2	S	64	HIS
2	S	73	LEU
2	S	130	SER
2	S	132	SER
2	S	185	GLN
2	S	217	LEU
2	S	256	LYS
2	S	259	ASP

Sometimes sidechains can be flipped to improve hydrogen bonding and reduce clashes. All (6) such sidechains are listed below:

Mol	Chain	Res	Type
2	S	43	ASN
2	S	64	HIS
2	S	103	GLN
2	S	185	GLN
2	S	252	ASN
2	S	275	GLN

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](#)

Of 4 ligands modelled in this entry, 4 are monoatomic - leaving 0 for Mogul analysis.

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 ⓘ

There are no chain breaks in this entry.

6 Fit of model and data [i](#)

6.1 Protein, DNA and RNA chains [i](#)

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	P	71/80 (88%)	-0.08	1 (1%) 73 79	11, 17, 25, 35	0
2	S	263/266 (98%)	-0.11	8 (3%) 52 58	7, 13, 27, 39	0
All	All	334/346 (96%)	-0.10	9 (2%) 56 63	7, 14, 27, 39	0

All (9) RSRZ outliers are listed below:

Mol	Chain	Res	Type	RSRZ
2	S	4	VAL	7.6
2	S	40	PRO	7.0
2	S	41	ASP	4.6
2	S	275	GLN	3.7
2	S	5	SER	3.2
1	P	9	GLU	2.8
2	S	38	SER	2.7
2	S	25	ASN	2.6
2	S	214	TYR	2.6

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 oligosaccharides 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
3	ZN	S	281	1/1	0.93	0.04	26,26,26,26	0
3	ZN	S	280	1/1	0.98	0.05	37,37,37,37	0
3	ZN	S	278	1/1	0.99	0.03	28,28,28,28	0
3	ZN	S	279	1/1	1.00	0.03	18,18,18,18	0

6.5 Other polymers [i](#)

There are no such residues in this entry.