



wwPDB X-ray Structure Validation Summary Report ⓘ

Mar 5, 2026 – 06:34 PM UTC

PDB ID : 1TZO / pdb_00001tzo
Title : Crystal Structure of the Anthrax Toxin Protective Antigen Heptameric Pre-pore
Authors : Lacy, D.B.; Wigelsworth, D.J.; Melnyk, R.A.; Collier, R.J.
Deposited on : 2004-07-10
Resolution : 3.60 Å(reported)

This is a wwPDB X-ray Structure Validation Summary 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

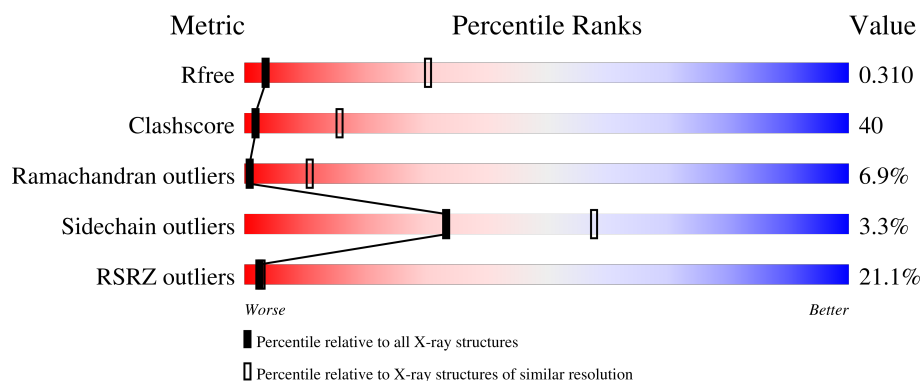
1 Overall quality at a glance

The following experimental techniques were used to determine the structure:

X-RAY DIFFRACTION

The reported resolution of this entry is 3.60 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	1747 (3.70-3.50)
Clashscore	190562	1827 (3.70-3.50)
Ramachandran outliers	187476	1773 (3.70-3.50)
Sidechain outliers	187428	1772 (3.70-3.50)
RSRZ outliers	180081	1745 (3.70-3.50)

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	A	562	12% 38% 54% 5%
1	B	562	36% 38% 54% 6%
1	C	562	18% 39% 54% 6%
1	D	562	40% 39% 52% 6%
1	E	562	13% 38% 54% 5%

Continued on next page...

Continued from previous page...

Mol	Chain	Length	Quality of chain
1	F	562	
1	G	562	
1	H	562	
1	I	562	
1	J	562	
1	K	562	
1	L	562	
1	M	562	
1	O	562	

2 Entry composition

There are 2 unique types of molecules in this entry. The entry contains 61138 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 Protective antigen.

Mol	Chain	Residues	Atoms					ZeroOcc	AltConf	Trace
1	A	553	Total	C	N	O	S	0	0	0
			4365	2730	753	876	6			
1	B	553	Total	C	N	O	S	0	0	0
			4365	2730	753	876	6			
1	C	553	Total	C	N	O	S	0	0	0
			4365	2730	753	876	6			
1	D	553	Total	C	N	O	S	0	0	0
			4365	2730	753	876	6			
1	E	553	Total	C	N	O	S	0	0	0
			4365	2730	753	876	6			
1	F	553	Total	C	N	O	S	0	0	0
			4365	2730	753	876	6			
1	G	553	Total	C	N	O	S	0	0	0
			4365	2730	753	876	6			
1	H	553	Total	C	N	O	S	0	0	0
			4365	2730	753	876	6			
1	I	553	Total	C	N	O	S	0	0	0
			4365	2730	753	876	6			
1	J	553	Total	C	N	O	S	0	0	0
			4365	2730	753	876	6			
1	K	553	Total	C	N	O	S	0	0	0
			4365	2730	753	876	6			
1	L	553	Total	C	N	O	S	0	0	0
			4365	2730	753	876	6			
1	M	553	Total	C	N	O	S	0	0	0
			4365	2730	753	876	6			
1	O	553	Total	C	N	O	S	0	0	0
			4365	2730	753	876	6			

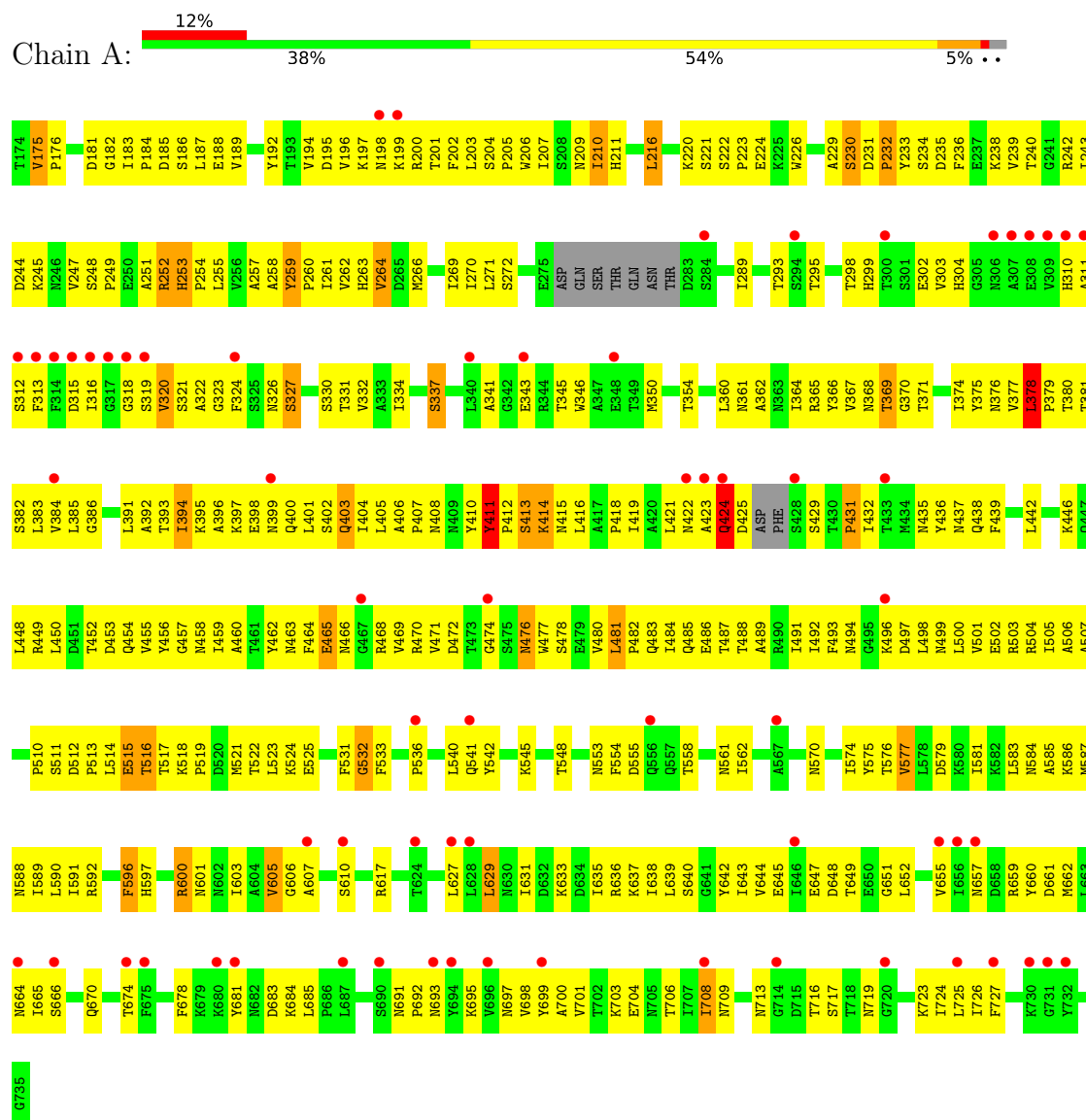
- Molecule 2 is CALCIUM ION (CCD ID: CA) (formula: Ca).

Mol	Chain	Residues	Atoms		ZeroOcc	AltConf
2	A	2	Total 2	Ca 2	0	0
2	B	2	Total 2	Ca 2	0	0
2	C	2	Total 2	Ca 2	0	0
2	D	2	Total 2	Ca 2	0	0
2	E	2	Total 2	Ca 2	0	0
2	F	2	Total 2	Ca 2	0	0
2	G	2	Total 2	Ca 2	0	0
2	H	2	Total 2	Ca 2	0	0
2	I	2	Total 2	Ca 2	0	0
2	J	2	Total 2	Ca 2	0	0
2	K	2	Total 2	Ca 2	0	0
2	L	2	Total 2	Ca 2	0	0
2	M	2	Total 2	Ca 2	0	0
2	O	2	Total 2	Ca 2	0	0

3 Residue-property plots

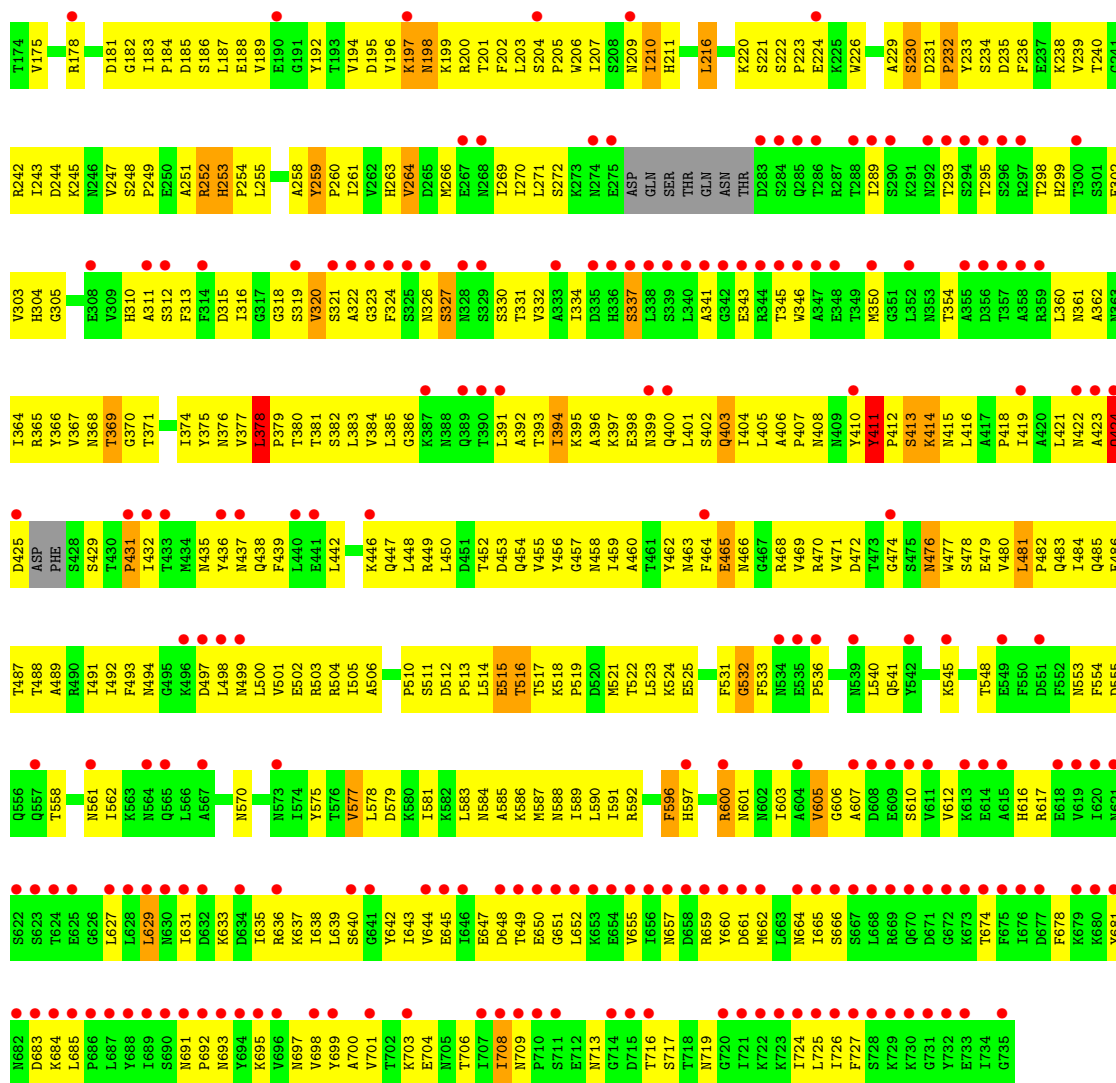
These plots are drawn for all protein, RNA, DNA and oligosaccharide chains in the entry. The first graphic for a chain summarises the proportions of the various outlier classes displayed in the second graphic. The second graphic shows the sequence view annotated by issues in geometry and electron density. 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: Protective antigen

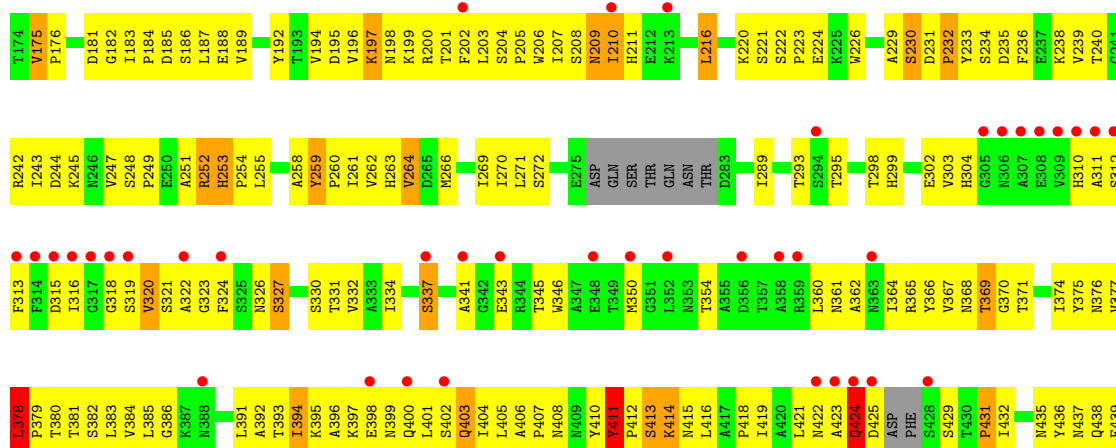


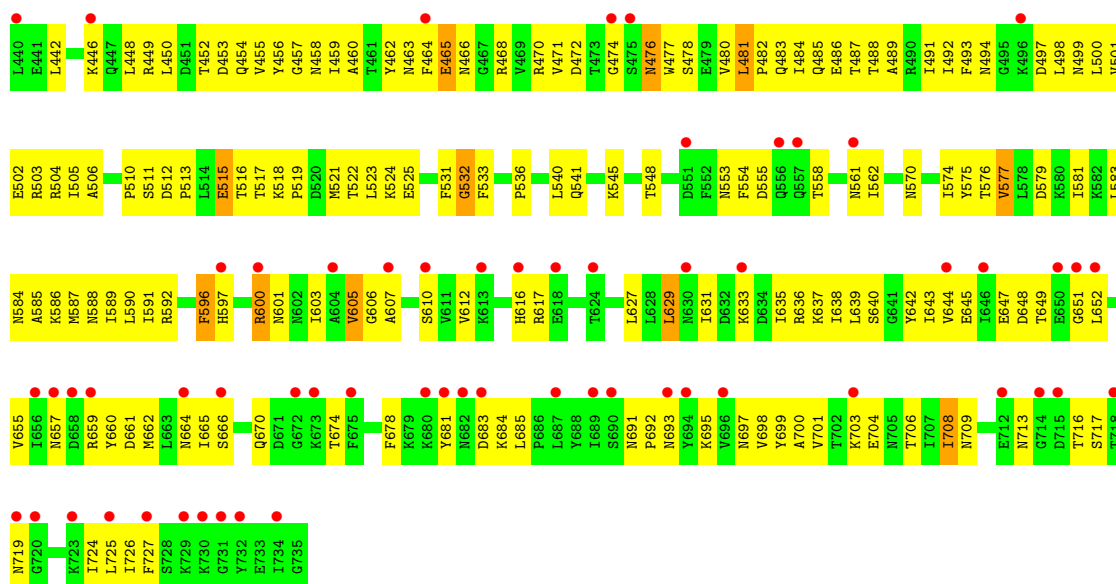
• Molecule 1: Protective antigen



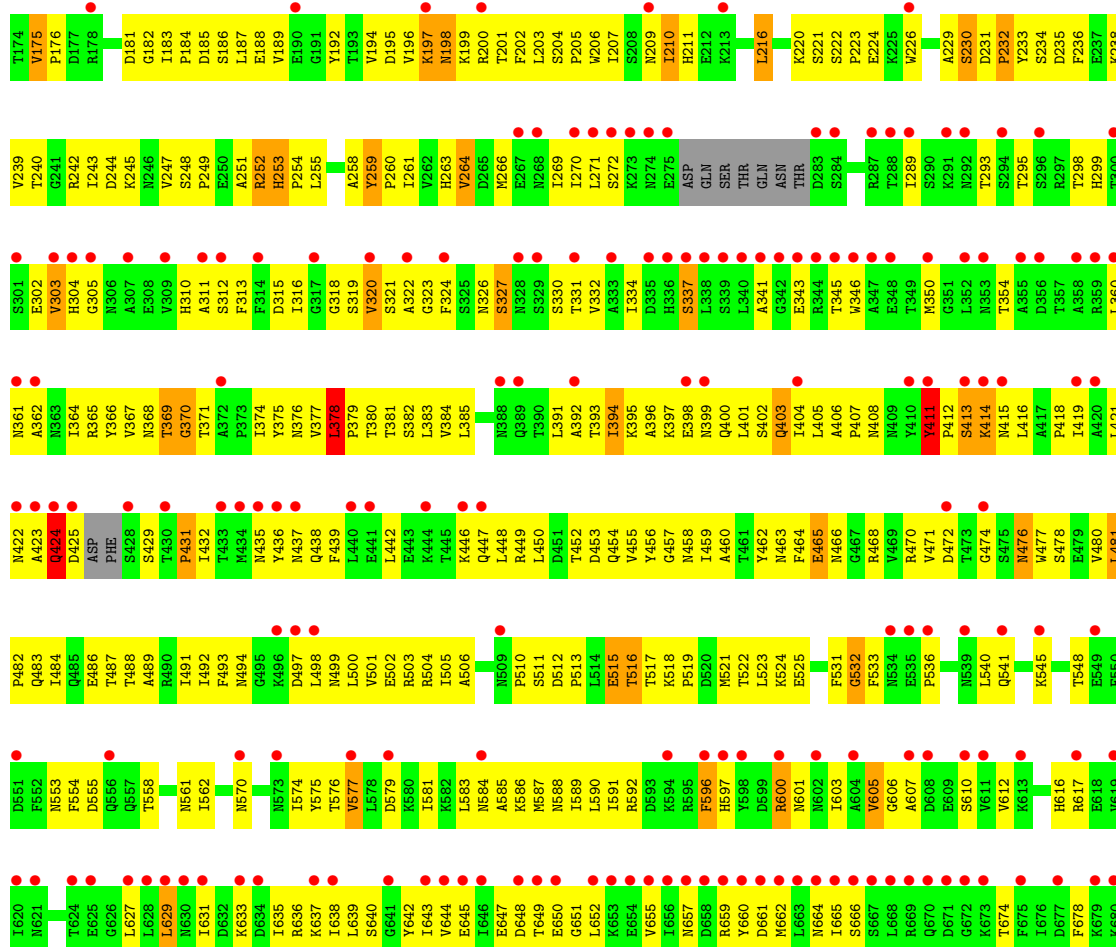


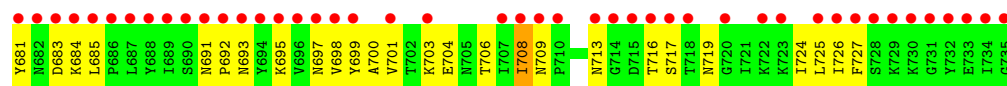
• Molecule 1: Protective antigen



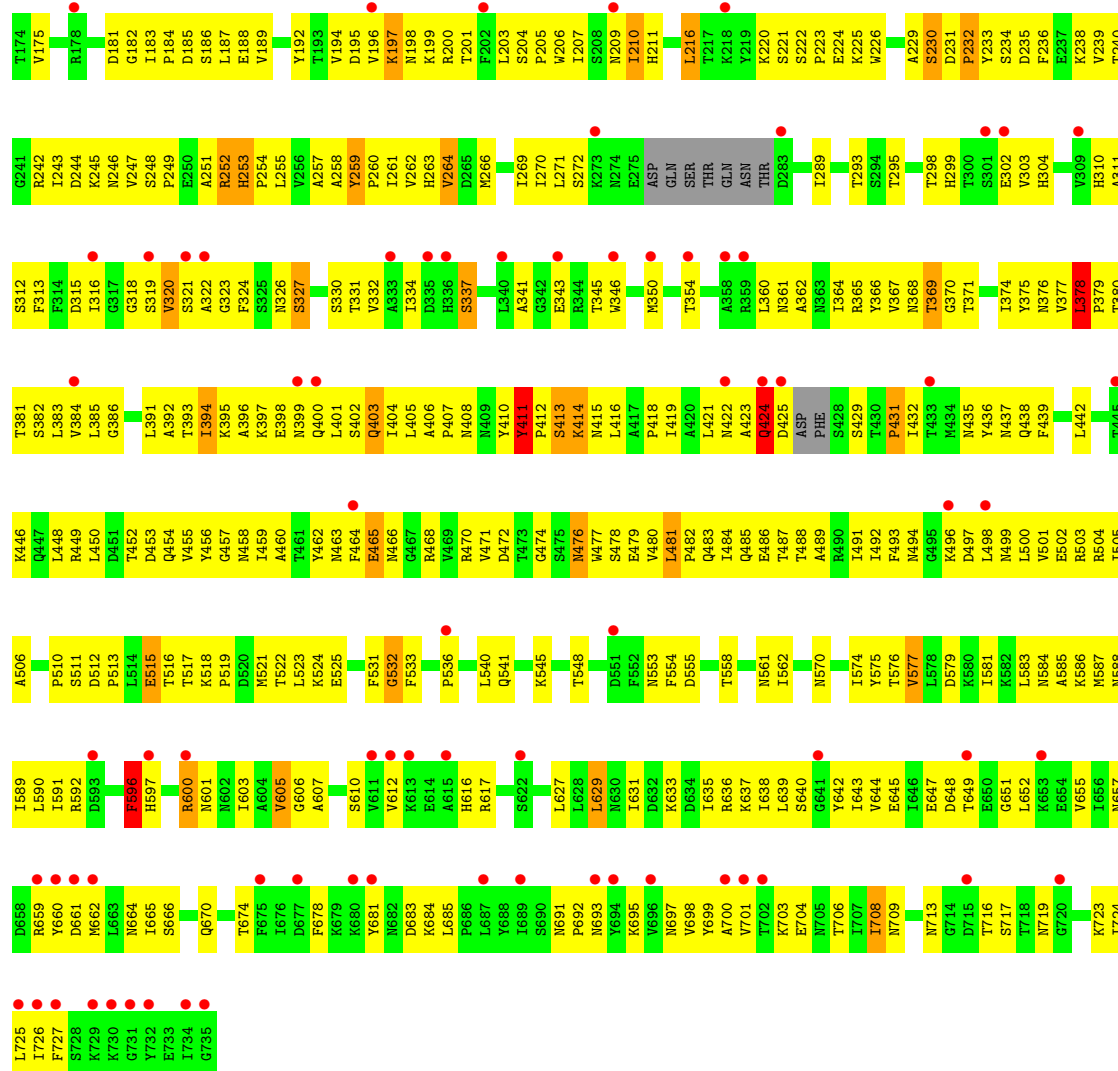


• Molecule 1: Protective antigen

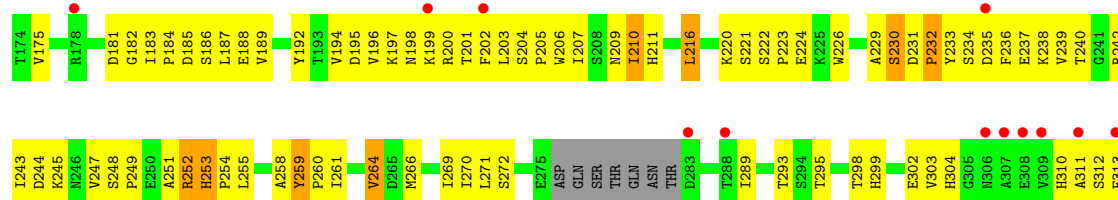




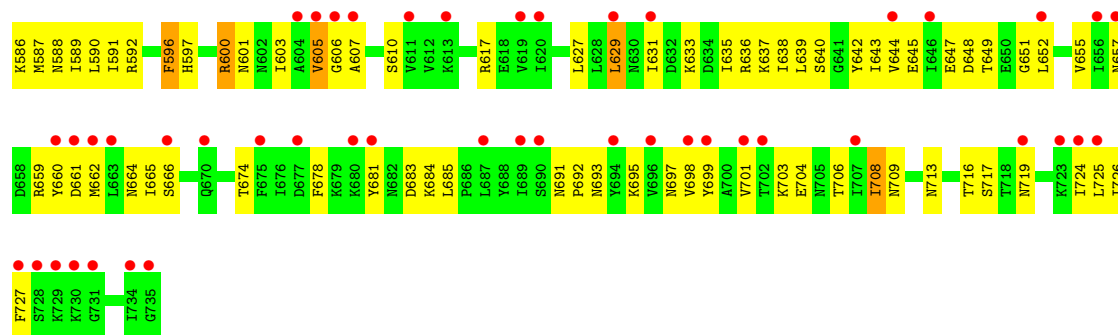
● Molecule 1: Protective antigen



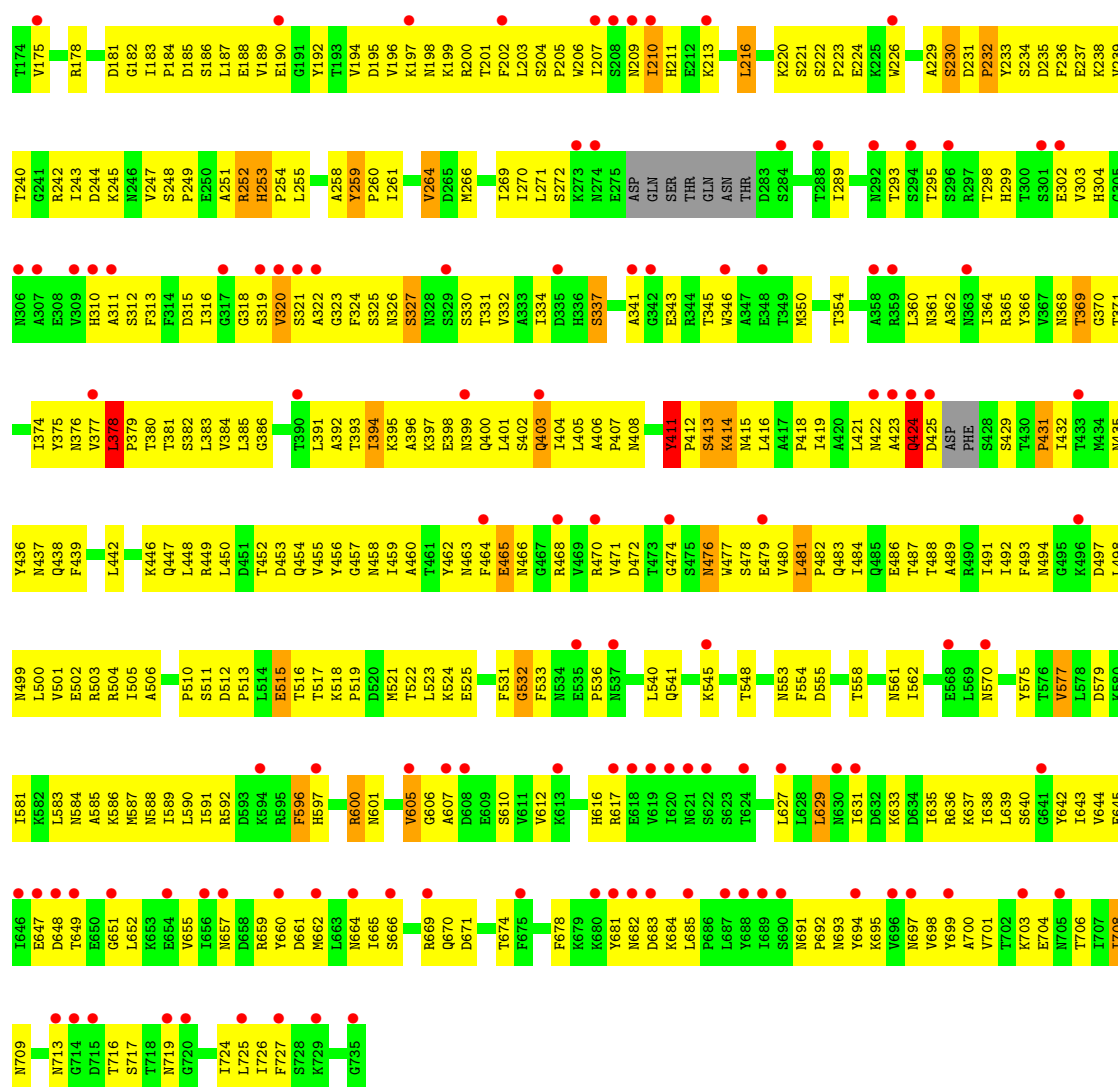
● Molecule 1: Protective antigen





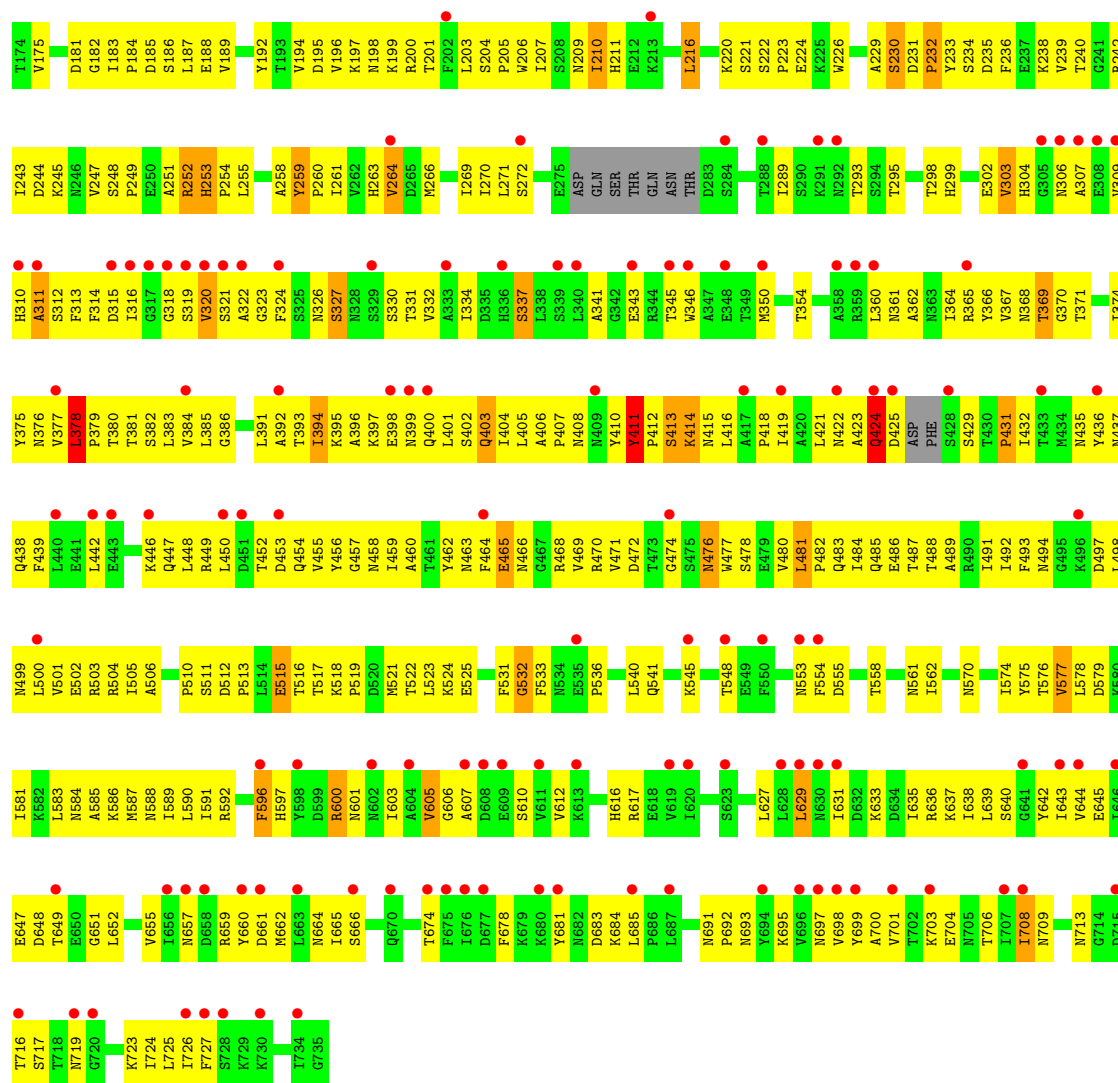


• Molecule 1: Protective antigen

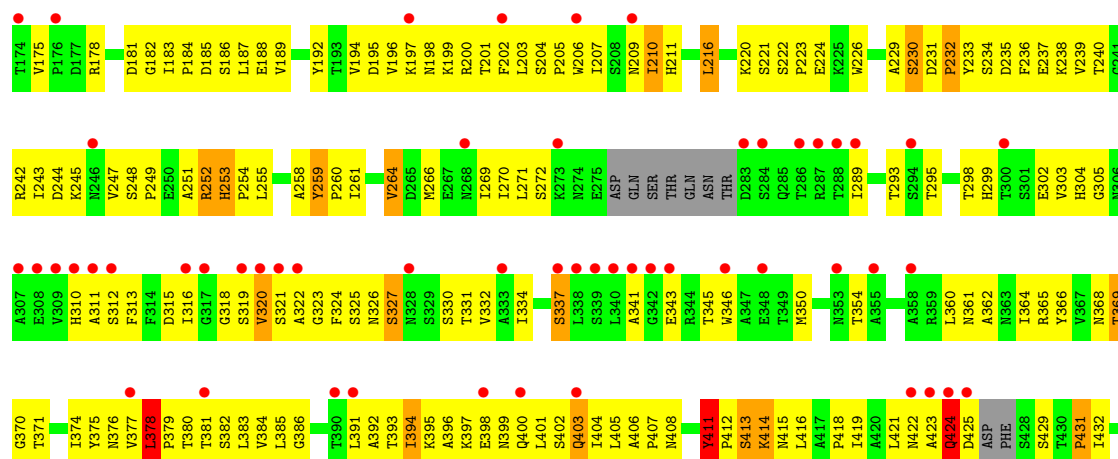


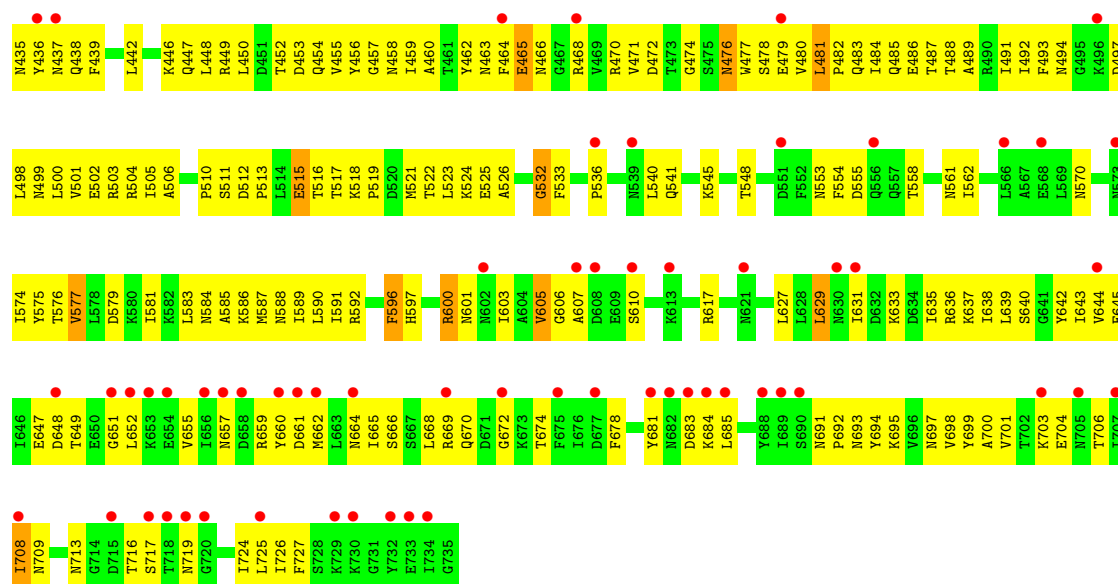
• Molecule 1: Protective antigen



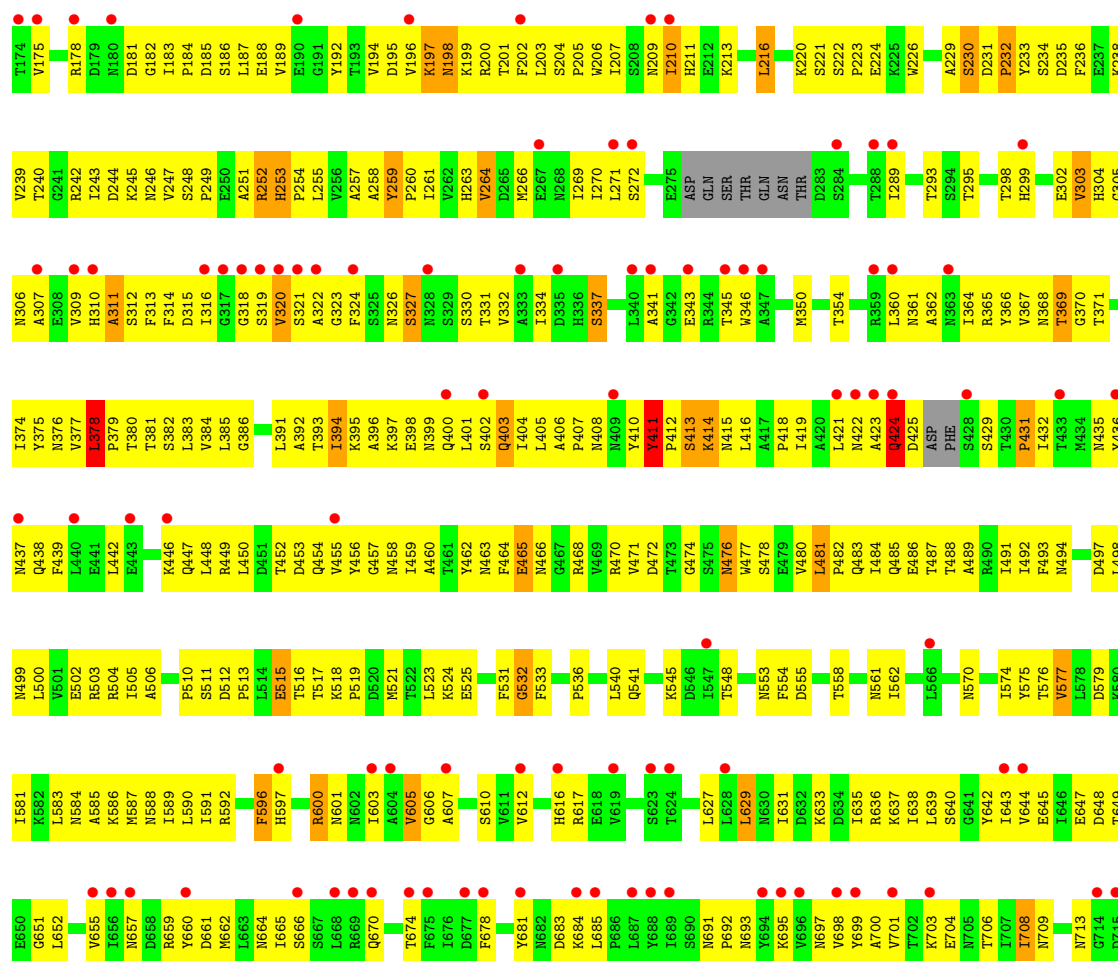


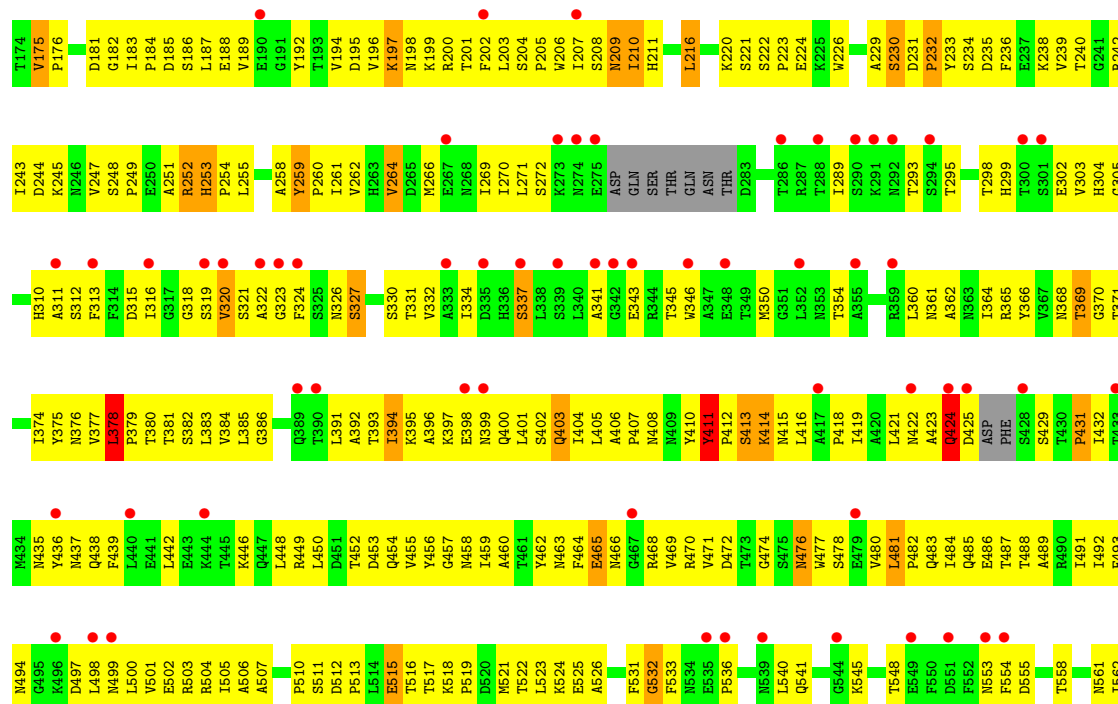
• Molecule 1: Protective antigen

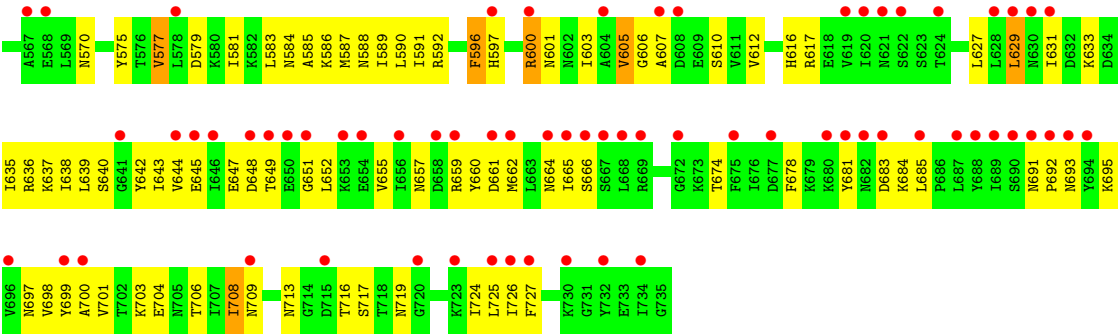




• Molecule 1: Protective antigen







4 Data and refinement statistics

Property	Value	Source
Space group	P 1	Depositor
Cell constants a, b, c, α , β , γ	149.61Å 167.03Å 168.20Å 77.56° 75.74° 76.01°	Depositor
Resolution (Å)	30.00 – 3.60 30.00 – 3.60	Depositor EDS
% Data completeness (in resolution range)	93.2 (30.00-3.60) 93.0 (30.00-3.60)	Depositor EDS
R_{merge}	(Not available)	Depositor
R_{sym}	0.05	Depositor
$\langle I/\sigma(I) \rangle$ ¹	1.25 (at 3.56Å)	Xtriage
Refinement program	CNS	Depositor
R, R_{free}	0.314 , 0.317 0.307 , 0.310	Depositor DCC
R_{free} test set	8182 reflections (5.02%)	wwPDB-VP
Wilson B-factor (Å ²)	74.3	Xtriage
Anisotropy	0.164	Xtriage
Bulk solvent k_{sol} (e/Å ³), B_{sol} (Å ²)	0.26 , 86.8	EDS
L-test for twinning ²	$\langle L \rangle = 0.47$, $\langle L^2 \rangle = 0.30$	Xtriage
Estimated twinning fraction	0.019 for -h,-l,-k	Xtriage
F_o, F_c correlation	0.83	EDS
Total number of atoms	61138	wwPDB-VP
Average B, all atoms (Å ²)	93.0	wwPDB-VP

Xtriage's analysis on translational NCS is as follows: *The largest off-origin peak in the Patterson function is 3.06% 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:
CA

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	0.37	0/4439	0.92	17/6018 (0.3%)
1	B	0.36	0/4439	0.92	16/6018 (0.3%)
1	C	0.36	0/4439	0.92	17/6018 (0.3%)
1	D	0.36	0/4439	0.92	16/6018 (0.3%)
1	E	0.36	0/4439	0.92	18/6018 (0.3%)
1	F	0.36	0/4439	0.92	16/6018 (0.3%)
1	G	0.36	0/4439	0.92	16/6018 (0.3%)
1	H	0.36	0/4439	0.91	16/6018 (0.3%)
1	I	0.36	0/4439	0.92	16/6018 (0.3%)
1	J	0.36	0/4439	0.92	16/6018 (0.3%)
1	K	0.36	0/4439	0.92	16/6018 (0.3%)
1	L	0.36	0/4439	0.92	17/6018 (0.3%)
1	M	0.36	0/4439	0.92	17/6018 (0.3%)
1	O	0.36	0/4439	0.92	17/6018 (0.3%)
All	All	0.36	0/62146	0.92	231/84252 (0.3%)

There are no bond length outliers.

The worst 5 of 231 bond angle outliers are listed below:

Mol	Chain	Res	Type	Atoms	Z	Observed(°)	Ideal(°)
1	F	424	GLN	OE1-CD-NE2	-9.83	112.77	122.60
1	L	424	GLN	OE1-CD-NE2	-9.82	112.78	122.60
1	D	424	GLN	OE1-CD-NE2	-9.80	112.80	122.60
1	E	424	GLN	OE1-CD-NE2	-9.80	112.80	122.60
1	I	424	GLN	OE1-CD-NE2	-9.80	112.80	122.60

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	4365	0	4318	361	0
1	B	4365	0	4318	361	9
1	C	4365	0	4318	355	5
1	D	4365	0	4318	354	6
1	E	4365	0	4318	357	3
1	F	4365	0	4318	363	0
1	G	4365	0	4318	358	1
1	H	4365	0	4318	381	10
1	I	4365	0	4318	391	0
1	J	4365	0	4318	386	3
1	K	4365	0	4318	380	4
1	L	4365	0	4318	373	10
1	M	4365	0	4318	375	5
1	O	4365	0	4318	362	10
2	A	2	0	0	0	0
2	B	2	0	0	0	0
2	C	2	0	0	0	0
2	D	2	0	0	0	0
2	E	2	0	0	0	0
2	F	2	0	0	0	0
2	G	2	0	0	0	0
2	H	2	0	0	0	0
2	I	2	0	0	0	0
2	J	2	0	0	0	0
2	K	2	0	0	0	0
2	L	2	0	0	0	0
2	M	2	0	0	0	0
2	O	2	0	0	0	0
All	All	61138	0	60452	4815	33

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 40.

The worst 5 of 4815 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:H:319:SER:N	1:I:414:LYS:HG3	1.61	1.15
1:H:319:SER:H	1:I:414:LYS:HG3	0.99	1.11
1:H:642:TYR:HB2	1:H:665:ILE:HD11	1.43	1.01
1:M:642:TYR:HB2	1:M:665:ILE:HD11	1.43	1.01
1:J:642:TYR:HB2	1:J:665:ILE:HD11	1.43	1.01

The worst 5 of 33 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:C:197:LYS:NZ	1:H:694:TYR:OH[1_545]	0.73	1.47
1:E:197:LYS:NZ	1:J:694:TYR:OH[1_544]	0.83	1.37
1:L:694:TYR:OH	1:O:197:LYS:NZ[1_556]	0.90	1.30
1:B:659:ARG:CZ	1:M:213:LYS:NZ[1_455]	1.33	0.87
1:L:694:TYR:OH	1:O:197:LYS:CE[1_556]	1.38	0.82

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	547/562 (97%)	402 (74%)	107 (20%)	38 (7%)	1	11
1	B	547/562 (97%)	402 (74%)	107 (20%)	38 (7%)	1	11
1	C	547/562 (97%)	402 (74%)	107 (20%)	38 (7%)	1	11
1	D	547/562 (97%)	402 (74%)	107 (20%)	38 (7%)	1	11
1	E	547/562 (97%)	402 (74%)	107 (20%)	38 (7%)	1	11
1	F	547/562 (97%)	402 (74%)	107 (20%)	38 (7%)	1	11
1	G	547/562 (97%)	402 (74%)	107 (20%)	38 (7%)	1	11
1	H	547/562 (97%)	402 (74%)	107 (20%)	38 (7%)	1	11
1	I	547/562 (97%)	402 (74%)	107 (20%)	38 (7%)	1	11
1	J	547/562 (97%)	402 (74%)	107 (20%)	38 (7%)	1	11

Continued on next page...

Continued from previous page...

Mol	Chain	Analysed	Favoured	Allowed	Outliers	Percentiles	
1	K	547/562 (97%)	402 (74%)	107 (20%)	38 (7%)	1	11
1	L	547/562 (97%)	402 (74%)	107 (20%)	38 (7%)	1	11
1	M	547/562 (97%)	402 (74%)	107 (20%)	38 (7%)	1	11
1	O	547/562 (97%)	402 (74%)	107 (20%)	38 (7%)	1	11
All	All	7658/7868 (97%)	5628 (74%)	1498 (20%)	532 (7%)	1	11

5 of 532 Ramachandran outliers are listed below:

Mol	Chain	Res	Type
1	A	198	ASN
1	A	337	SER
1	A	341	ALA
1	A	397	LYS
1	A	424	GLN

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	492/501 (98%)	476 (97%)	16 (3%)	33	58
1	B	492/501 (98%)	476 (97%)	16 (3%)	33	58
1	C	492/501 (98%)	476 (97%)	16 (3%)	33	58
1	D	492/501 (98%)	476 (97%)	16 (3%)	33	58
1	E	492/501 (98%)	476 (97%)	16 (3%)	33	58
1	F	492/501 (98%)	476 (97%)	16 (3%)	33	58
1	G	492/501 (98%)	476 (97%)	16 (3%)	33	58
1	H	492/501 (98%)	476 (97%)	16 (3%)	33	58
1	I	492/501 (98%)	476 (97%)	16 (3%)	33	58
1	J	492/501 (98%)	476 (97%)	16 (3%)	33	58
1	K	492/501 (98%)	476 (97%)	16 (3%)	33	58
1	L	492/501 (98%)	476 (97%)	16 (3%)	33	58

Continued on next page...

Continued from previous page...

Mol	Chain	Analysed	Rotameric	Outliers	Percentiles	
1	M	492/501 (98%)	476 (97%)	16 (3%)	33	58
1	O	492/501 (98%)	476 (97%)	16 (3%)	33	58
All	All	6888/7014 (98%)	6664 (97%)	224 (3%)	33	58

5 of 224 residues with a non-rotameric sidechain are listed below:

Mol	Chain	Res	Type
1	H	369	THR
1	O	605	VAL
1	I	708	ILE
1	O	596	PHE
1	M	476	ASN

Sometimes sidechains can be flipped to improve hydrogen bonding and reduce clashes. 5 of 325 such sidechains are listed below:

Mol	Chain	Res	Type
1	K	211	HIS
1	M	403	GLN
1	K	403	GLN
1	L	361	ASN
1	M	601	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 oligosaccharides in this entry.

5.6 Ligand geometry [i](#)

Of 28 ligands modelled in this entry, 28 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 [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	553/562 (98%)	0.93	66 (11%) 9 8	6, 90, 194, 205	0
1	B	553/562 (98%)	1.72	205 (37%) 1 1	6, 90, 194, 205	0
1	C	553/562 (98%)	1.08	100 (18%) 3 4	6, 90, 194, 205	0
1	D	553/562 (98%)	1.87	222 (40%) 0 1	6, 90, 194, 205	0
1	E	553/562 (98%)	1.00	75 (13%) 7 6	6, 90, 194, 205	0
1	F	553/562 (98%)	1.00	70 (12%) 8 7	6, 90, 194, 205	0
1	G	553/562 (98%)	1.16	98 (17%) 4 4	6, 90, 194, 205	0
1	H	553/562 (98%)	1.22	113 (20%) 3 3	6, 90, 194, 205	0
1	I	553/562 (98%)	1.29	125 (22%) 2 2	6, 90, 194, 205	0
1	J	553/562 (98%)	1.23	115 (20%) 2 3	6, 90, 194, 205	0
1	K	553/562 (98%)	1.13	103 (18%) 3 4	6, 90, 194, 205	0
1	L	553/562 (98%)	1.19	122 (22%) 2 2	6, 90, 194, 205	0
1	M	553/562 (98%)	1.06	93 (16%) 4 5	6, 90, 194, 205	0
1	O	553/562 (98%)	1.33	128 (23%) 2 2	6, 90, 194, 205	0
All	All	7742/7868 (98%)	1.23	1635 (21%) 2 3	6, 90, 194, 205	0

The worst 5 of 1635 RSRZ outliers are listed below:

Mol	Chain	Res	Type	RSRZ
1	D	688	TYR	8.5
1	D	683	ASP	7.9
1	D	322	ALA	7.7
1	H	209	ASN	7.5
1	B	322	ALA	7.2

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($\text{\AA}^2$)	Q<0.9
2	CA	E	737	1/1	0.96	0.12	18,18,18,18	0
2	CA	I	736	1/1	0.96	0.06	33,33,33,33	0
2	CA	O	736	1/1	0.96	0.07	33,33,33,33	0
2	CA	O	737	1/1	0.96	0.06	18,18,18,18	0
2	CA	G	736	1/1	0.97	0.07	33,33,33,33	0
2	CA	K	736	1/1	0.97	0.08	33,33,33,33	0
2	CA	G	737	1/1	0.98	0.07	18,18,18,18	0
2	CA	D	737	1/1	0.98	0.04	18,18,18,18	0
2	CA	I	737	1/1	0.98	0.06	18,18,18,18	0
2	CA	J	737	1/1	0.98	0.06	18,18,18,18	0
2	CA	A	736	1/1	0.98	0.07	33,33,33,33	0
2	CA	L	737	1/1	0.98	0.04	18,18,18,18	0
2	CA	F	737	1/1	0.98	0.06	18,18,18,18	0
2	CA	B	736	1/1	0.98	0.10	33,33,33,33	0
2	CA	H	736	1/1	0.99	0.04	33,33,33,33	0
2	CA	H	737	1/1	0.99	0.04	18,18,18,18	0
2	CA	A	737	1/1	0.99	0.02	18,18,18,18	0
2	CA	E	736	1/1	0.99	0.06	33,33,33,33	0
2	CA	J	736	1/1	0.99	0.05	33,33,33,33	0
2	CA	B	737	1/1	0.99	0.07	18,18,18,18	0
2	CA	F	736	1/1	0.99	0.04	33,33,33,33	0
2	CA	K	737	1/1	0.99	0.03	18,18,18,18	0
2	CA	L	736	1/1	0.99	0.04	33,33,33,33	0
2	CA	C	736	1/1	0.99	0.09	33,33,33,33	0
2	CA	M	736	1/1	0.99	0.03	33,33,33,33	0
2	CA	C	737	1/1	0.99	0.05	18,18,18,18	0
2	CA	D	736	1/1	0.99	0.04	33,33,33,33	0

Continued on next page...

Continued from previous page...

Mol	Type	Chain	Res	Atoms	RSCC	RSR	B-factors($\text{\AA}^2$)	Q<0.9
2	CA	M	737	1/1	1.00	0.02	18,18,18,18	0

6.5 Other polymers [i](#)

There are no such residues in this entry.