



wwPDB X-ray Structure Validation Summary Report ⓘ

Mar 4, 2026 – 11:33 PM UTC

PDB ID : 4H02 / pdb_00004h02
Title : Crystal structure of P. falciparum Lysyl-tRNA synthetase
Authors : Khan, S.; Garg, A.; Sharma, A.
Deposited on : 2012-09-07
Resolution : 2.90 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

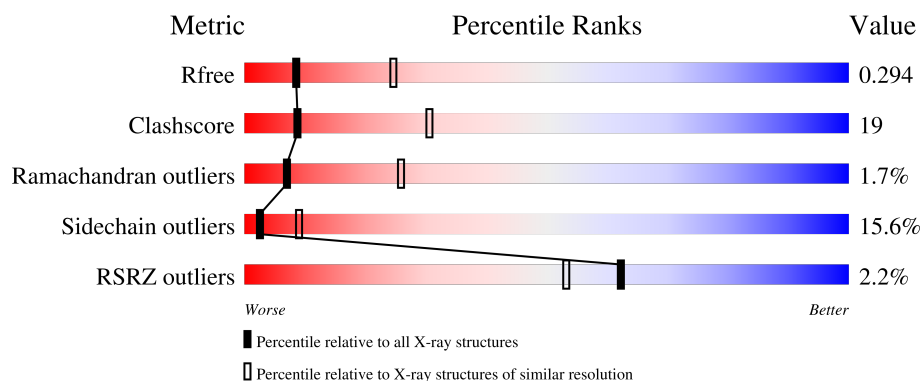
1 Overall quality at a glance ⓘ

The following experimental techniques were used to determine the structure:

X-RAY DIFFRACTION

The reported resolution of this entry is 2.90 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	2481 (2.90-2.90)
Clashscore	190562	2690 (2.90-2.90)
Ramachandran outliers	187476	2623 (2.90-2.90)
Sidechain outliers	187428	2625 (2.90-2.90)
RSRZ outliers	180081	2481 (2.90-2.90)

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	507	2% 48% 38% 6% 7%
1	B	507	2% 50% 33% 10% 7%
1	C	507	3% 50% 36% 7% 7%
1	D	507	2% 47% 37% 8% 7%
1	E	507	2% 50% 35% 8% 7%

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Mol	Chain	Length	Quality of chain
1	F	507	
1	G	507	
1	H	507	

2 Entry composition [i](#)

There are 2 unique types of molecules in this entry. The entry contains 30845 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 Lysyl-tRNA synthetase.

Mol	Chain	Residues	Atoms					ZeroOcc	AltConf	Trace
1	A	469	Total	C	N	O	S	0	3	0
			3848	2488	639	704	17			
1	B	471	Total	C	N	O	S	0	1	0
			3852	2490	640	705	17			
1	C	471	Total	C	N	O	S	0	0	0
			3844	2484	639	705	16			
1	D	471	Total	C	N	O	S	0	0	0
			3849	2488	640	705	16			
1	E	470	Total	C	N	O	S	0	0	0
			3833	2477	638	702	16			
1	F	470	Total	C	N	O	S	0	1	0
			3843	2485	638	704	16			
1	G	470	Total	C	N	O	S	0	0	0
			3840	2483	638	703	16			
1	H	471	Total	C	N	O	S	0	0	0
			3839	2481	639	703	16			

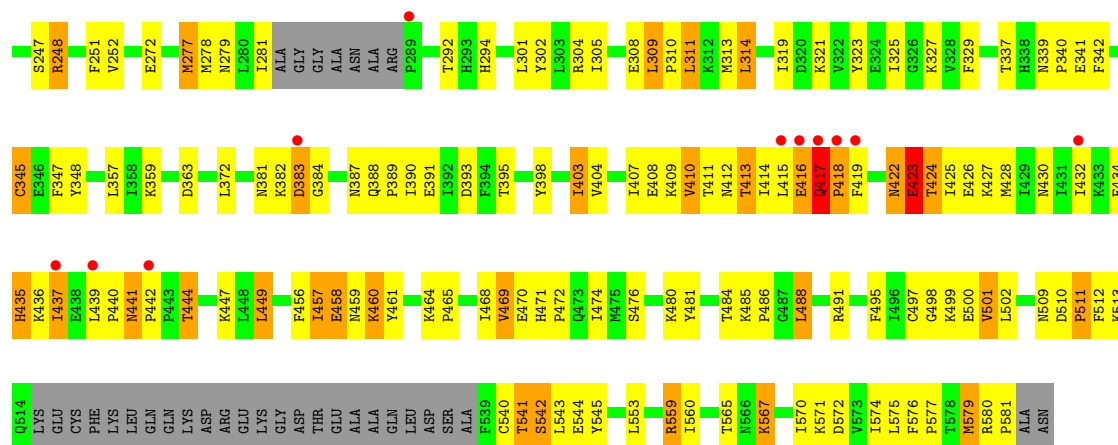
- Molecule 2 is water.

Mol	Chain	Residues	Atoms		ZeroOcc	AltConf
2	A	10	Total	O	0	0
			10	10		
2	B	14	Total	O	0	0
			14	14		
2	C	13	Total	O	0	0
			13	13		
2	D	16	Total	O	0	0
			16	16		
2	E	9	Total	O	0	0
			9	9		
2	F	8	Total	O	0	0
			8	8		

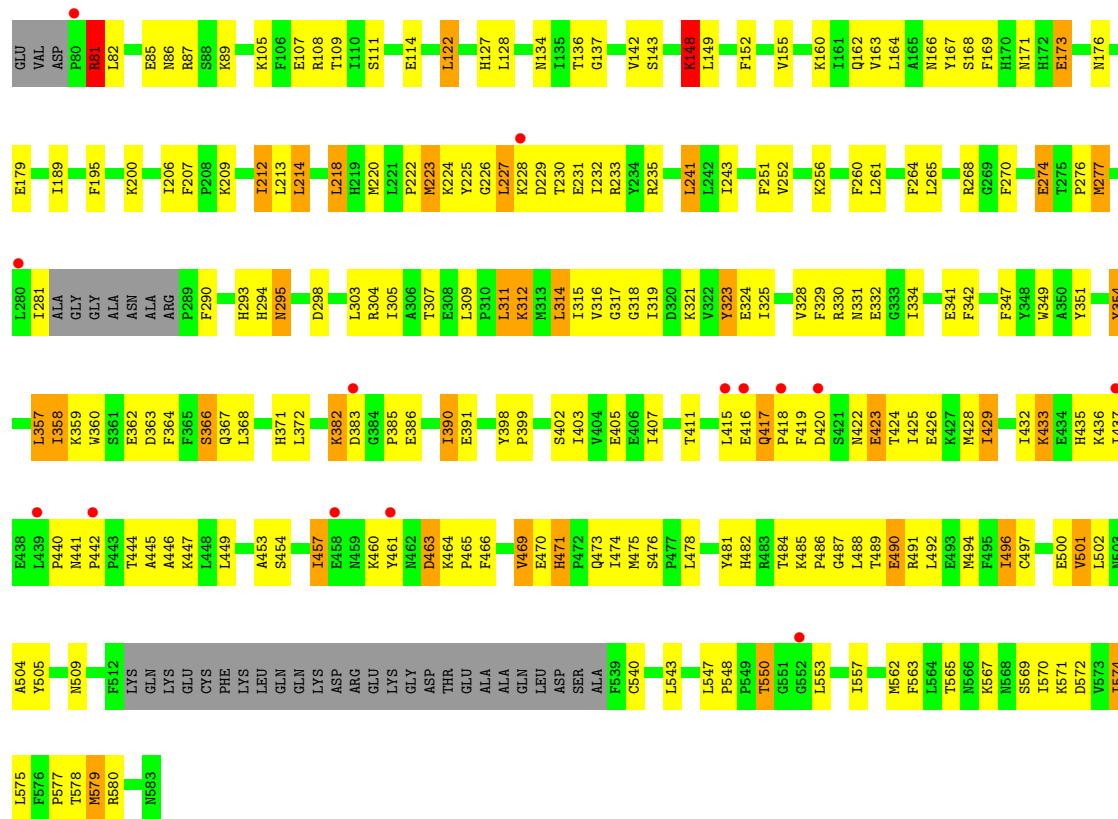
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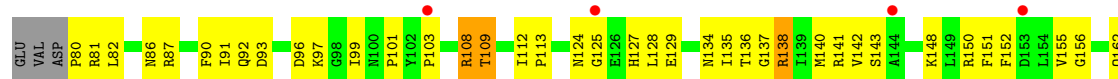
Mol	Chain	Residues	Atoms		ZeroOcc	AltConf
2	G	9	Total	O	0	0
			9	9		
2	H	18	Total	O	0	0
			18	18		

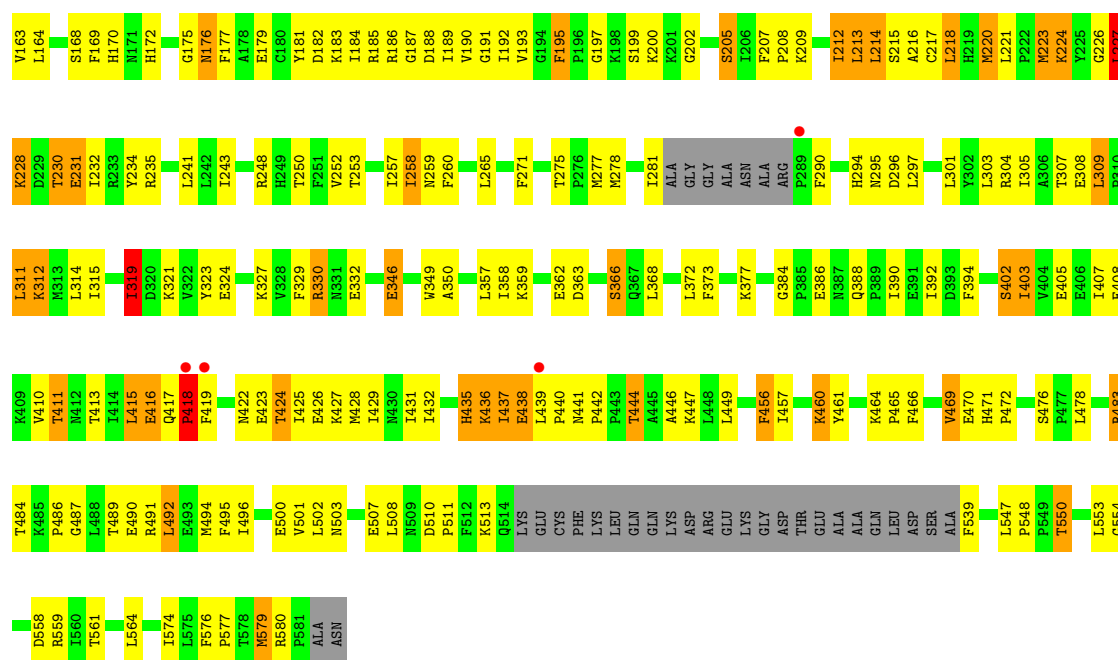


• Molecule 1: Lysyl-tRNA synthetase

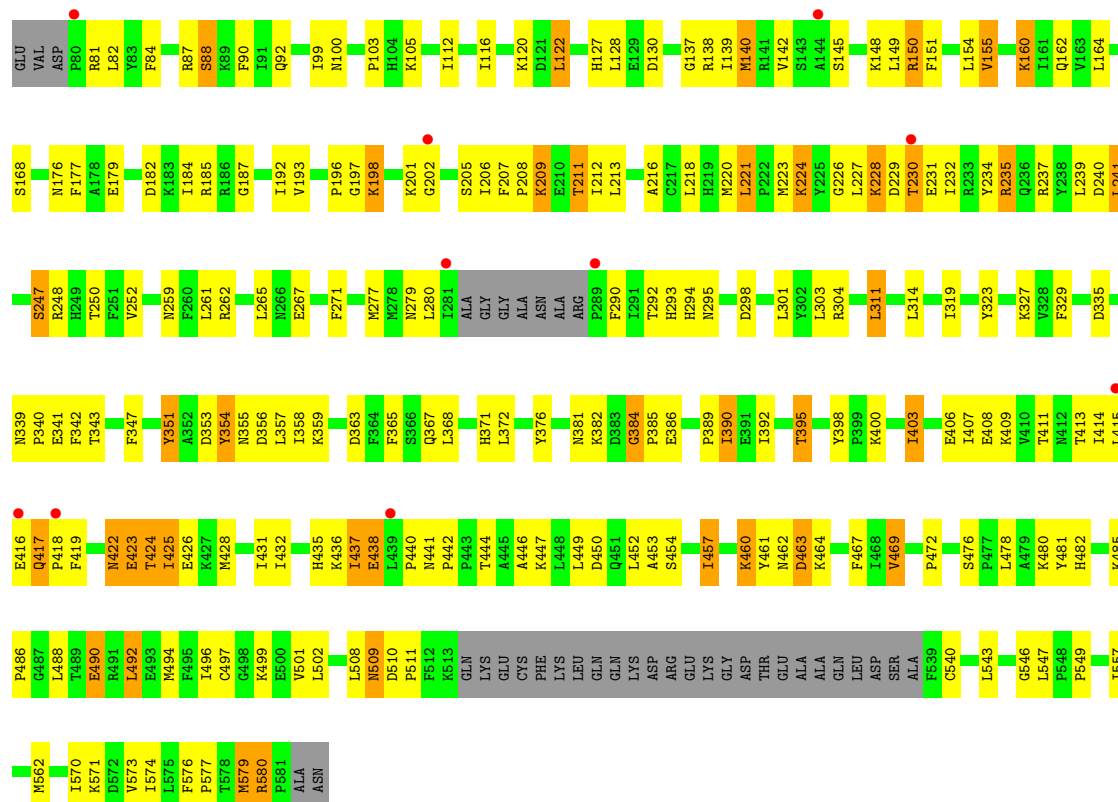


• Molecule 1: Lysyl-tRNA synthetase



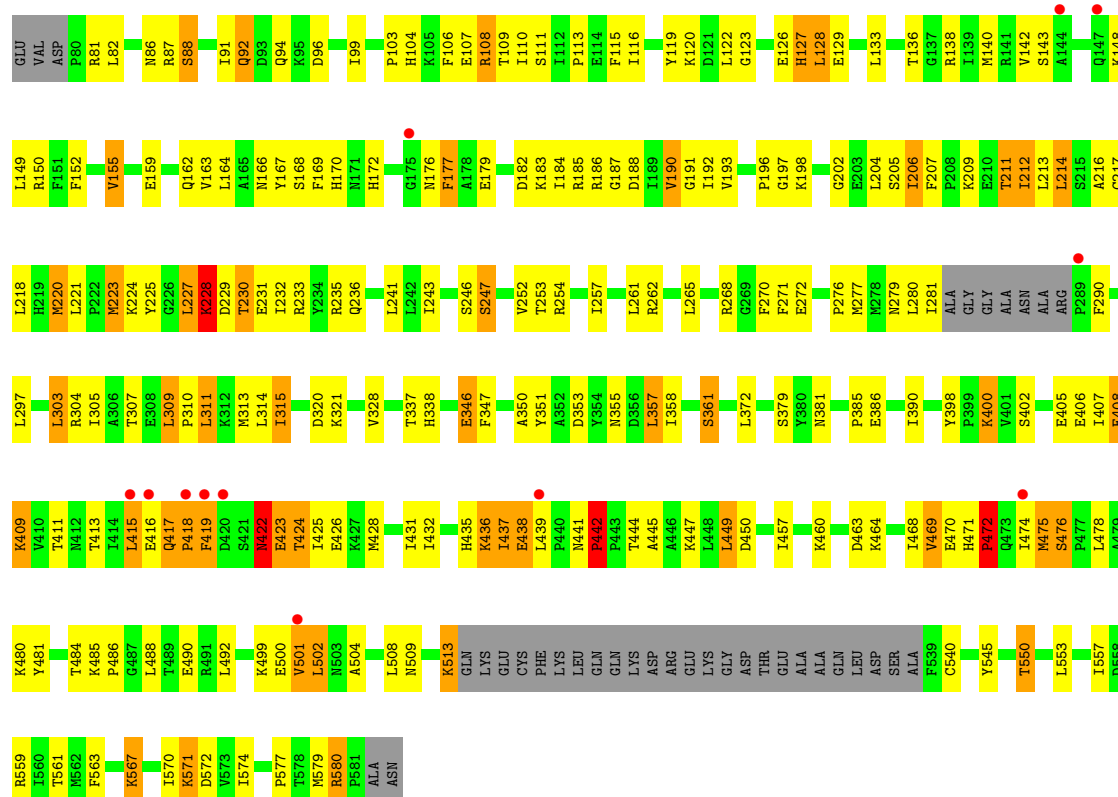


• Molecule 1: Lysyl-tRNA synthetase

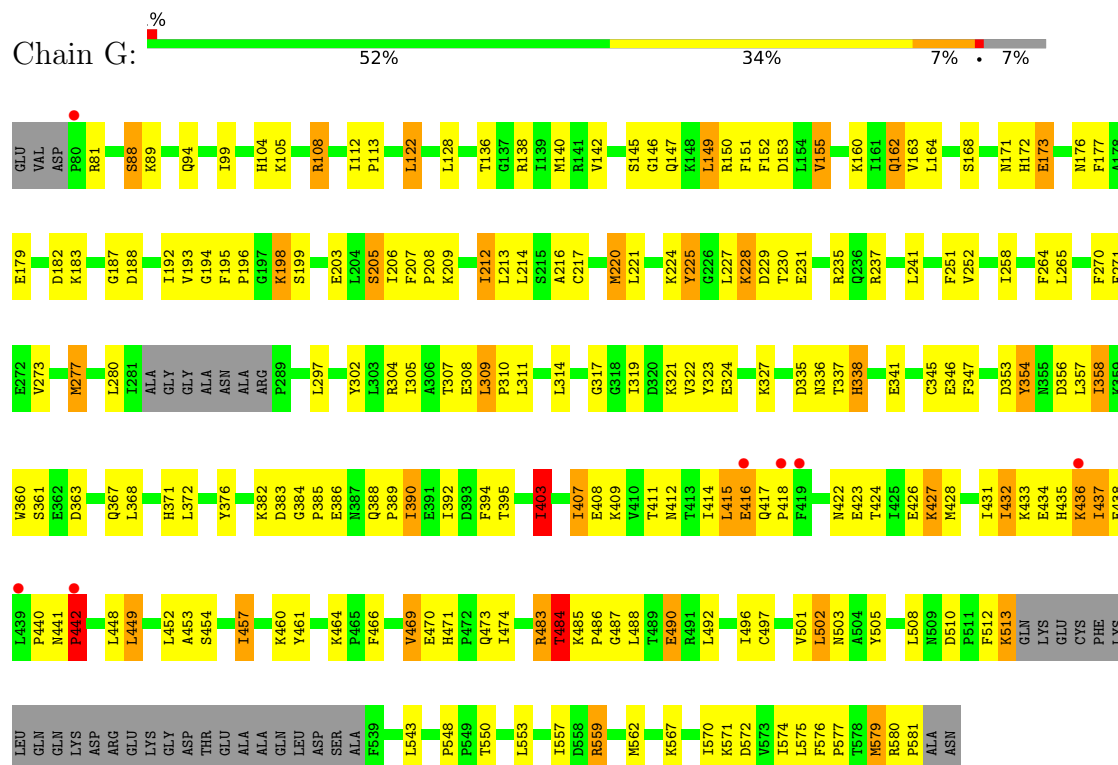


• Molecule 1: Lysyl-tRNA synthetase





• Molecule 1: Lysyl-tRNA synthetase



• Molecule 1: Lysyl-tRNA synthetase



4 Data and refinement statistics

Property	Value	Source
Space group	P 1 21 1	Depositor
Cell constants a, b, c, α , β , γ	141.33Å 59.14Å 297.22Å 90.00° 97.47° 90.00°	Depositor
Resolution (Å)	48.70 – 2.90 48.70 – 2.90	Depositor EDS
% Data completeness (in resolution range)	95.1 (48.70-2.90) 93.3 (48.70-2.90)	Depositor EDS
R_{merge}	0.11	Depositor
R_{sym}	(Not available)	Depositor
$\langle I/\sigma(I) \rangle$ ¹	4.22 (at 2.91Å)	Xtriage
Refinement program	PHENIX 1.7.1_743, REFMAC	Depositor
R, R_{free}	0.226 , 0.298 0.221 , 0.294	Depositor DCC
R_{free} test set	3110 reflections (2.85%)	wwPDB-VP
Wilson B-factor (Å ²)	46.4	Xtriage
Anisotropy	0.632	Xtriage
Bulk solvent k_{sol} (e/Å ³), B_{sol} (Å ²)	0.31 , 42.5	EDS
L-test for twinning ²	$\langle L \rangle = 0.39$, $\langle L^2 \rangle = 0.22$	Xtriage
Estimated twinning fraction	No twinning to report.	Xtriage
F_o, F_c correlation	0.90	EDS
Total number of atoms	30845	wwPDB-VP
Average B, all atoms (Å ²)	53.0	wwPDB-VP

Xtriage's analysis on translational NCS is as follows: *The largest off-origin peak in the Patterson function is 8.90% 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

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	0.57	0/3954	0.96	8/5342 (0.1%)
1	B	0.58	0/3952	1.01	9/5339 (0.2%)
1	C	0.63	1/3941 (0.0%)	1.01	9/5326 (0.2%)
1	D	0.61	0/3946	0.96	11/5331 (0.2%)
1	E	0.62	2/3929 (0.1%)	0.96	8/5308 (0.2%)
1	F	0.59	0/3943	0.94	5/5327 (0.1%)
1	G	0.60	0/3937	0.98	12/5319 (0.2%)
1	H	0.61	0/3935	0.96	8/5316 (0.2%)
All	All	0.60	3/31537 (0.0%)	0.97	70/42608 (0.2%)

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	2
1	D	0	3
1	F	0	1
1	G	0	2
1	H	0	1
All	All	0	9

All (3) bond length outliers are listed below:

Mol	Chain	Res	Type	Atoms	Z	Observed(Å)	Ideal(Å)
1	C	360	TRP	NE1-CE2	-6.25	1.30	1.37
1	E	127	HIS	CG-ND1	-6.24	1.31	1.38
1	E	127	HIS	ND1-CE1	5.36	1.38	1.32

The worst 5 of 70 bond angle outliers are listed below:

Mol	Chain	Res	Type	Atoms	Z	Observed(°)	Ideal(°)
1	A	416	GLU	N-CA-C	-8.36	103.67	114.04
1	A	148	LYS	N-CA-C	-8.06	103.24	113.72
1	B	148	LYS	N-CA-C	-8.04	103.48	113.38
1	G	209	LYS	N-CA-C	-7.98	103.67	113.41
1	F	148	LYS	N-CA-C	-7.78	103.39	113.12

There are no chirality outliers.

5 of 9 planarity outliers are listed below:

Mol	Chain	Res	Type	Group
1	A	416	GLU	Peptide
1	A	418	PRO	Peptide
1	D	227	LEU	Peptide
1	D	416	GLU	Peptide
1	D	418	PRO	Peptide

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	3848	0	3817	152	0
1	B	3852	0	3819	155	1
1	C	3844	0	3804	148	0
1	D	3849	0	3814	161	0
1	E	3833	0	3799	143	0
1	F	3843	0	3811	144	0
1	G	3840	0	3806	130	1
1	H	3839	0	3803	161	0
2	A	10	0	0	1	0
2	B	14	0	0	2	0
2	C	13	0	0	0	0
2	D	16	0	0	0	0
2	E	9	0	0	1	0
2	F	8	0	0	1	0
2	G	9	0	0	1	0
2	H	18	0	0	1	0
All	All	30845	0	30473	1143	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 19.

The worst 5 of 1143 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:C:547:LEU:HD12	1:C:548:PRO:HD2	1.33	1.09
1:G:469:VAL:HG13	1:G:470:GLU:HG3	1.35	1.05
1:H:417:GLN:O	1:H:419:PHE:N	1.92	1.01
1:D:308:GLU:HG3	1:D:309:LEU:HD13	1.40	1.01
1:C:578:THR:O	1:C:579:MET:HE3	1.64	0.96

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:B:167:TYR:OH	1:G:434:GLU:OE2[1_465]	1.96	0.24

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	A	466/507 (92%)	425 (91%)	35 (8%)	6 (1%)	9	32
1	B	466/507 (92%)	414 (89%)	44 (9%)	8 (2%)	7	26
1	C	465/507 (92%)	408 (88%)	51 (11%)	6 (1%)	9	32
1	D	465/507 (92%)	410 (88%)	49 (10%)	6 (1%)	9	32
1	E	464/507 (92%)	417 (90%)	40 (9%)	7 (2%)	8	28
1	F	465/507 (92%)	420 (90%)	33 (7%)	12 (3%)	4	17
1	G	464/507 (92%)	419 (90%)	33 (7%)	12 (3%)	4	17
1	H	465/507 (92%)	419 (90%)	38 (8%)	8 (2%)	7	26
All	All	3720/4056 (92%)	3332 (90%)	323 (9%)	65 (2%)	7	26

5 of 65 Ramachandran outliers are listed below:

Mol	Chain	Res	Type
1	A	437	ILE
1	B	416	GLU
1	B	418	PRO
1	B	423	GLU
1	B	458	GLU

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	427/457 (93%)	371 (87%)	56 (13%)	4	13
1	B	427/457 (93%)	356 (83%)	71 (17%)	2	7
1	C	425/457 (93%)	361 (85%)	64 (15%)	3	10
1	D	426/457 (93%)	355 (83%)	71 (17%)	2	7
1	E	424/457 (93%)	361 (85%)	63 (15%)	3	10
1	F	426/457 (93%)	348 (82%)	78 (18%)	2	6
1	G	425/457 (93%)	364 (86%)	61 (14%)	3	11
1	H	424/457 (93%)	357 (84%)	67 (16%)	2	8
All	All	3404/3656 (93%)	2873 (84%)	531 (16%)	2	9

5 of 531 residues with a non-rotameric sidechain are listed below:

Mol	Chain	Res	Type
1	G	579	MET
1	H	204	LEU
1	G	562	MET
1	H	460	LYS
1	D	109	THR

Sometimes sidechains can be flipped to improve hydrogen bonding and reduce clashes. 5 of 60 such sidechains are listed below:

Mol	Chain	Res	Type
1	E	339	ASN
1	H	294	HIS
1	F	94	GLN
1	H	293	HIS
1	H	503	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](#)

There are no ligands in this entry.

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	469/507 (92%)	0.07	9 (1%) 66 58	22, 45, 91, 122	3 (0%)
1	B	471/507 (92%)	0.05	12 (2%) 58 48	22, 47, 88, 118	1 (0%)
1	C	471/507 (92%)	0.17	14 (2%) 52 43	22, 48, 93, 129	0
1	D	471/507 (92%)	0.19	8 (1%) 69 61	22, 49, 91, 121	0
1	E	470/507 (92%)	0.07	10 (2%) 63 54	26, 49, 92, 126	0
1	F	470/507 (92%)	0.12	12 (2%) 57 48	26, 51, 92, 118	1 (0%)
1	G	470/507 (92%)	0.06	7 (1%) 72 64	27, 49, 90, 123	0
1	H	471/507 (92%)	0.08	9 (1%) 66 58	26, 50, 91, 125	0
All	All	3763/4056 (92%)	0.10	81 (2%) 62 53	22, 49, 92, 129	5 (0%)

The worst 5 of 81 RSRZ outliers are listed below:

Mol	Chain	Res	Type	RSRZ
1	D	418	PRO	4.0
1	E	144	ALA	3.9
1	H	144	ALA	3.9
1	G	439	LEU	3.4
1	C	442	PRO	3.3

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

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

6.3 Carbohydrates ⓘ

There are no oligosaccharides in this entry.

6.4 Ligands [i](#)

There are no ligands in this entry.

6.5 Other polymers [i](#)

There are no such residues in this entry.