



wwPDB X-ray Structure Validation Summary Report ⓘ

Mar 5, 2026 – 08:01 PM UTC

PDB ID : 6UK6 / pdb_00006uk6
Title : Crystal structure of human GAC in complex with inhibitor UPGL00018
Authors : Huang, Q.; Cerione, R.A.
Deposited on : 2019-10-04
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
Mogul : 2022.3.0, CSD as543be (2022)
Xtriage (Phenix) : 2.0
EDS : 3.0
Buster-report : wwPDB partial adaption of 1.1.7 (2018)
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

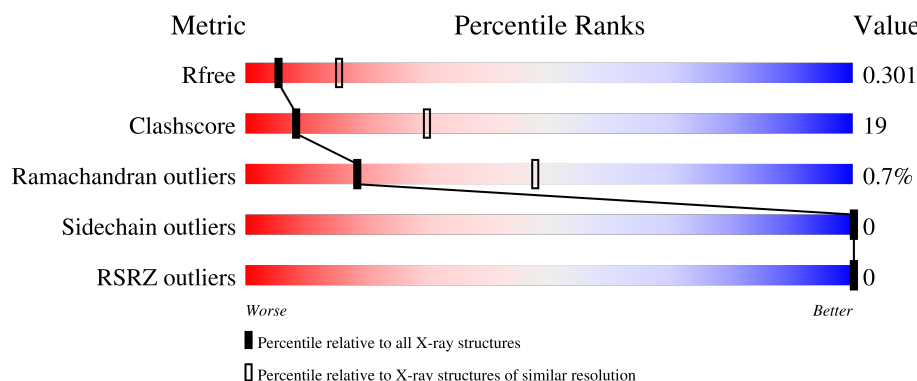
1 Overall quality at a glance

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	527	 49% 28% 23%
1	B	527	 47% 27% 24%
1	C	527	 49% 26% 24%
1	D	527	 50% 24% 25%

The following table lists non-polymeric compounds, carbohydrate monomers and non-standard

residues in protein, DNA, RNA chains that are outliers for geometric or electron-density-fit criteria:

Mol	Type	Chain	Res	Chirality	Geometry	Clashes	Electron density
2	Q9S	A	601	-	X	-	-
2	Q9S	D	601	-	X	-	-

2 Entry composition

There are 2 unique types of molecules in this entry. The entry contains 12524 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.

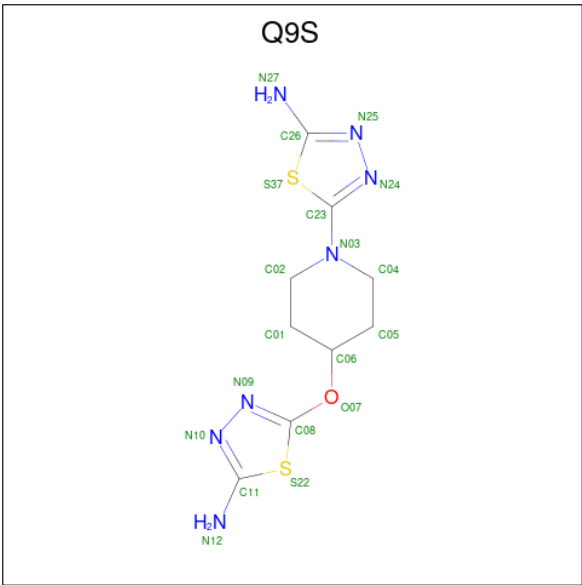
- Molecule 1 is a protein called Glutaminase kidney isoform, mitochondrial.

Mol	Chain	Residues	Atoms					ZeroOcc	AltConf	Trace
1	A	404	Total	C	N	O	S	1	0	0
			3151	2006	532	585	28			
1	B	398	Total	C	N	O	S	1	0	0
			3108	1983	525	572	28			
1	C	402	Total	C	N	O	S	1	0	0
			3128	1988	530	582	28			
1	D	397	Total	C	N	O	S	1	0	0
			3099	1975	524	572	28			

There are 4 discrepancies between the modelled and reference sequences:

Chain	Residue	Modelled	Actual	Comment	Reference
A	268	ALA	VAL	conflict	UNP O94925
B	268	ALA	VAL	conflict	UNP O94925
C	268	ALA	VAL	conflict	UNP O94925
D	268	ALA	VAL	conflict	UNP O94925

- Molecule 2 is 5-{4-[(5-amino-1,3,4-thiadiazol-2-yl)oxy]piperidin-1-yl}-1,3,4-thiadiazol-2-amine (CCD ID: Q9S) (formula: C₉H₁₃N₇OS₂) (labeled as "Ligand of Interest" by depositor).

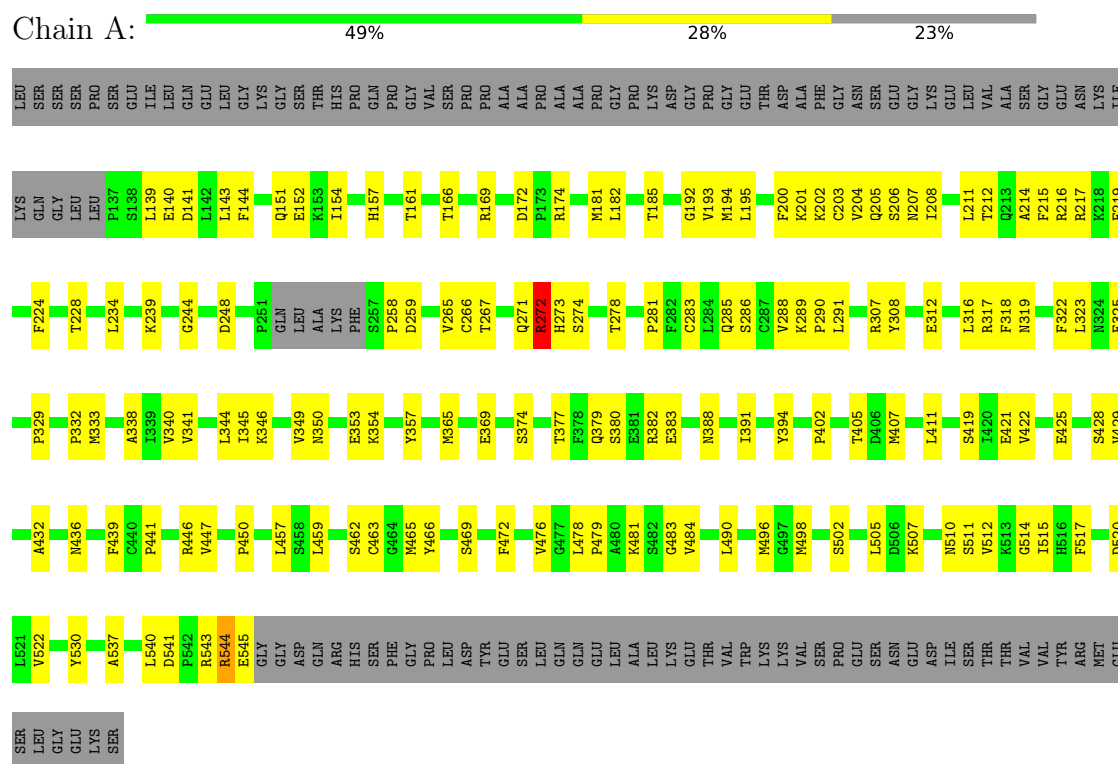


Mol	Chain	Residues	Atoms					ZeroOcc	AltConf
2	A	1	Total	C	N	O	S	0	0
			19	9	7	1	2		
2	D	1	Total	C	N	O	S	0	0
			19	9	7	1	2		

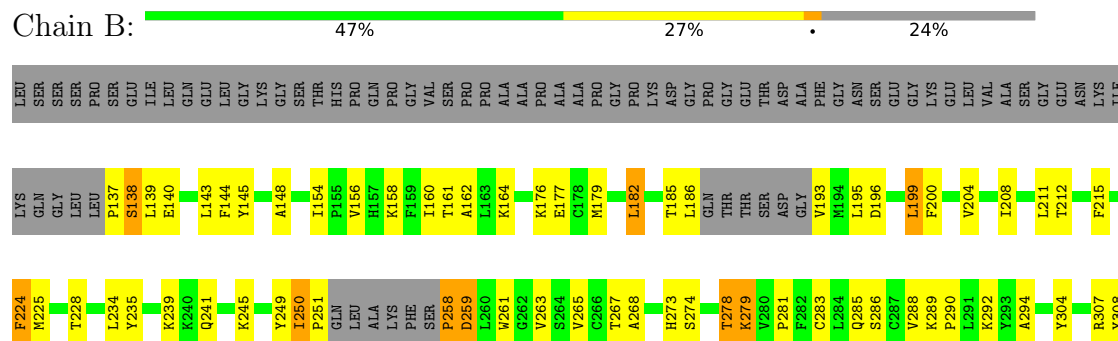
3 Residue-property plots

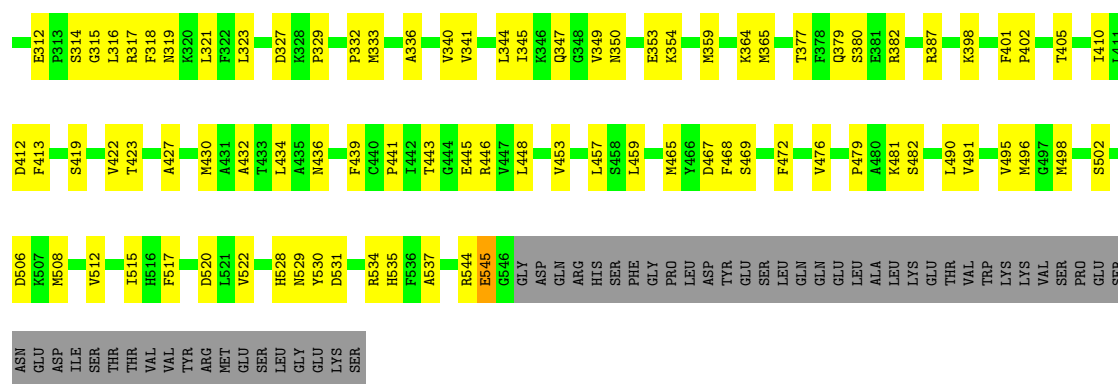
These plots are drawn for all protein, RNA, DNA and oligosaccharide chains in the entry. The first graphic for a chain summarises the proportions of the various outlier classes displayed in the second graphic. The second graphic shows the sequence view annotated by issues in geometry and electron density.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



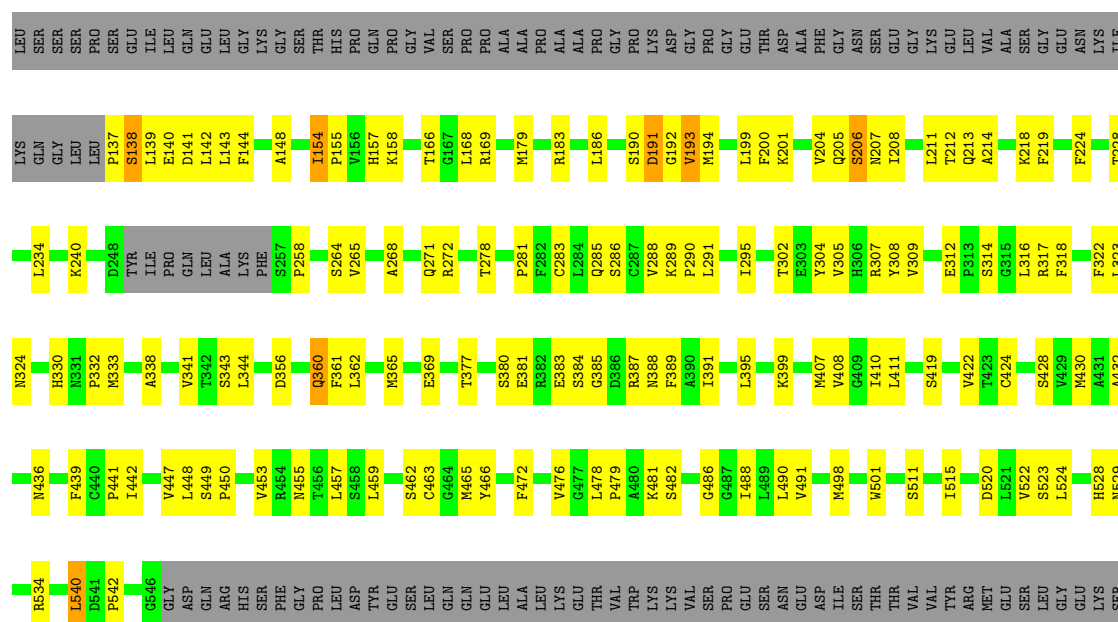
- Molecule 1: Glutaminase kidney isoform, mitochondrial





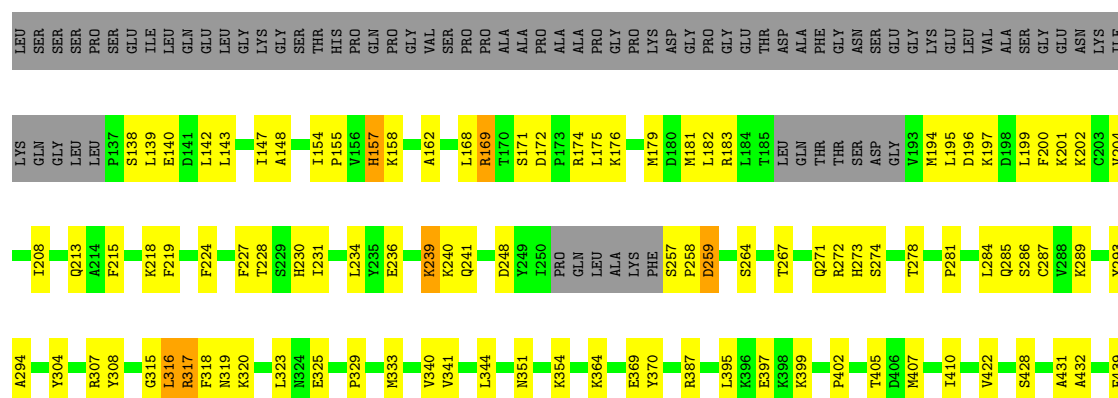
• Molecule 1: Glutaminase kidney isoform, mitochondrial

Chain C: 49% 26% 24%



• Molecule 1: Glutaminase kidney isoform, mitochondrial

Chain D: 50% 24% 25%



C440	P441	E445	R446	V447	L448	S449	P450	M465	Y466	D467	F468	S469	G470	Q471	F472	V476	K481	S482	L489	P493	M494	V495	M496	G497	M498	M499	P504	V512	I515	D520	L521	V522	S523	F527	H528	N529	Y530	A537	L540	D541	P542	G546	GLY	ASP	GLN			
ARG	HIS	SER	PHE	GLY	PRO	LEU	LEU	ASP	TYR	GLU	SER	LEU	GLN	GLN	GLU	ALA	LEU	LYS	GLU	THR	VAL	TRP	LYS	LYS	VAL	SER	PRO	GLU	SER	ASN	GLU	ASP	ILE	SER	THR	THR	VAL	VAL	TYR	ARG	MET	GLU	SER	LEU	GLY	GLU	LYS	SER

4 Data and refinement statistics

Property	Value	Source
Space group	P 1 21 1	Depositor
Cell constants a, b, c, α , β , γ	54.44Å 138.79Å 179.05Å 90.00° 89.99° 90.00°	Depositor
Resolution (Å)	22.05 – 2.90 22.05 – 2.90	Depositor EDS
% Data completeness (in resolution range)	95.7 (22.05-2.90) 95.6 (22.05-2.90)	Depositor EDS
R_{merge}	(Not available)	Depositor
R_{sym}	0.14	Depositor
$\langle I/\sigma(I) \rangle$ ¹	1.86 (at 2.89Å)	Xtriage
Refinement program	PHENIX 1.15.2_3472	Depositor
R, R_{free}	0.239 , 0.308 0.239 , 0.301	Depositor DCC
R_{free} test set	2011 reflections (2.76%)	wwPDB-VP
Wilson B-factor (Å ²)	60.8	Xtriage
Anisotropy	1.005	Xtriage
Bulk solvent k_{sol} (e/Å ³), B_{sol} (Å ²)	0.23 , 35.1	EDS
L-test for twinning ²	$\langle L \rangle = 0.55$, $\langle L^2 \rangle = 0.40$	Xtriage
Estimated twinning fraction	0.458 for h,-k,-l	Xtriage
F_o, F_c correlation	0.97	EDS
Total number of atoms	12524	wwPDB-VP
Average B, all atoms (Å ²)	98.0	wwPDB-VP

Xtriage's analysis on translational NCS is as follows: *The largest off-origin peak in the Patterson function is 5.81% 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 [i](#)

5.1 Standard geometry [i](#)

Bond lengths and bond angles in the following residue types are not validated in this section: Q9S

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	0.93	5/3221 (0.2%)	1.06	30/4347 (0.7%)
1	B	0.57	1/3177 (0.0%)	1.04	26/4284 (0.6%)
1	C	0.54	1/3196 (0.0%)	0.98	16/4311 (0.4%)
1	D	0.57	1/3167 (0.0%)	1.09	24/4270 (0.6%)
All	All	0.67	8/12761 (0.1%)	1.04	96/17212 (0.6%)

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	B	0	3
1	C	0	2
All	All	0	7

The worst 5 of 8 bond length outliers are listed below:

Mol	Chain	Res	Type	Atoms	Z	Observed(Å)	Ideal(Å)
1	A	154	ILE	CA-C	-38.48	1.25	1.52
1	A	154	ILE	CA-CB	12.12	1.63	1.54
1	A	154	ILE	C-O	10.92	1.33	1.23
1	A	154	ILE	N-CA	9.99	1.55	1.46
1	A	154	ILE	C-N	7.42	1.43	1.33

The worst 5 of 96 bond angle outliers are listed below:

Mol	Chain	Res	Type	Atoms	Z	Observed(°)	Ideal(°)
1	A	154	ILE	CA-C-O	15.00	128.81	119.51

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Mol	Chain	Res	Type	Atoms	Z	Observed(°)	Ideal(°)
1	D	169	ARG	CA-CB-CG	13.26	140.62	114.10
1	A	154	ILE	O-C-N	-13.15	107.83	121.11
1	B	199	LEU	CB-CG-CD2	-11.67	75.69	110.70
1	D	317	ARG	NE-CZ-NH1	-10.64	110.86	121.50

There are no chirality outliers.

5 of 7 planarity outliers are listed below:

Mol	Chain	Res	Type	Group
1	A	248	ASP	Peptide
1	A	272	ARG	Sidechain
1	B	137	PRO	Peptide
1	B	138	SER	Peptide
1	B	258	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	3151	0	3122	120	0
1	B	3108	0	3086	130	0
1	C	3128	0	3098	134	0
1	D	3099	0	3070	125	0
2	A	19	0	0	2	0
2	D	19	0	0	0	0
All	All	12524	0	12376	477	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 19.

The worst 5 of 477 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:272:ARG:NH1	1:A:429:VAL:HG22	1.53	1.24
1:C:139:LEU:CD1	1:C:208:ILE:HG12	1.75	1.16

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Atom-1	Atom-2	Interatomic distance (Å)	Clash overlap (Å)
1:C:139:LEU:HD13	1:C:208:ILE:CG1	1.79	1.12
1:C:139:LEU:HD13	1:C:208:ILE:HG12	1.23	1.07
1:B:535:HIS:HD2	1:C:439:PHE:CD1	1.76	1.03

There are no symmetry-related clashes.

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	400/527 (76%)	377 (94%)	20 (5%)	3 (1%)	16	44
1	B	392/527 (74%)	369 (94%)	20 (5%)	3 (1%)	16	44
1	C	398/527 (76%)	375 (94%)	20 (5%)	3 (1%)	16	44
1	D	391/527 (74%)	370 (95%)	19 (5%)	2 (0%)	24	54
All	All	1581/2108 (75%)	1491 (94%)	79 (5%)	11 (1%)	18	48

5 of 11 Ramachandran outliers are listed below:

Mol	Chain	Res	Type
1	A	259	ASP
1	D	259	ASP
1	A	193	VAL
1	B	545	GLU
1	C	193	VAL

5.3.2 Protein sidechains [i](#)

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	350/451 (78%)	350 (100%)	0	100	100
1	B	344/451 (76%)	344 (100%)	0	100	100
1	C	347/451 (77%)	347 (100%)	0	100	100
1	D	343/451 (76%)	343 (100%)	0	100	100
All	All	1384/1804 (77%)	1384 (100%)	0	100	100

There are no protein residues with a non-rotameric sidechain to report.

Sometimes sidechains can be flipped to improve hydrogen bonding and reduce clashes. 5 of 19 such sidechains are listed below:

Mol	Chain	Res	Type
1	C	461	HIS
1	D	388	ASN
1	D	529	ASN
1	D	213	GLN
1	B	461	HIS

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 ⓘ

2 ligands are modelled in this entry.

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	$\# Z > 2$
2	Q9S	D	601	-	21,21,21	2.80	7 (33%)	28,29,29	6.69	20 (71%)
2	Q9S	A	601	-	21,21,21	2.77	8 (38%)	28,29,29	7.08	22 (78%)

In the following table, the Chirals column lists the number of chiral outliers, the number of chiral centers analysed, the number of these observed in the model and the number defined in the Chemical Component Dictionary. Similar counts are reported in the Torsion and Rings columns. '-' means no outliers of that kind were identified.

Mol	Type	Chain	Res	Link	Chirals	Torsions	Rings
2	Q9S	D	601	-	-	4/6/18/18	0/3/3/3
2	Q9S	A	601	-	-	3/6/18/18	0/3/3/3

The worst 5 of 15 bond length outliers are listed below:

Mol	Chain	Res	Type	Atoms	Z	Observed(Å)	Ideal(Å)
2	A	601	Q9S	C11-N12	6.02	1.46	1.34
2	D	601	Q9S	C26-N27	5.79	1.45	1.34
2	D	601	Q9S	C11-N12	5.77	1.45	1.34
2	A	601	Q9S	C26-N27	5.66	1.45	1.34
2	D	601	Q9S	C23-N03	4.95	1.45	1.34

The worst 5 of 42 bond angle outliers are listed below:

Mol	Chain	Res	Type	Atoms	Z	Observed(°)	Ideal(°)
2	A	601	Q9S	C06-O07-C08	-15.02	107.84	117.71
2	A	601	Q9S	C11-S22-C08	14.10	97.64	87.02
2	A	601	Q9S	S22-C11-N10	-13.81	103.89	113.79
2	D	601	Q9S	S22-C11-N10	-12.89	104.55	113.79
2	D	601	Q9S	C11-S22-C08	12.87	96.71	87.02

There are no chirality outliers.

5 of 7 torsion outliers are listed below:

Mol	Chain	Res	Type	Atoms
2	A	601	Q9S	N24-C23-N03-C04
2	D	601	Q9S	N24-C23-N03-C02
2	D	601	Q9S	N24-C23-N03-C04

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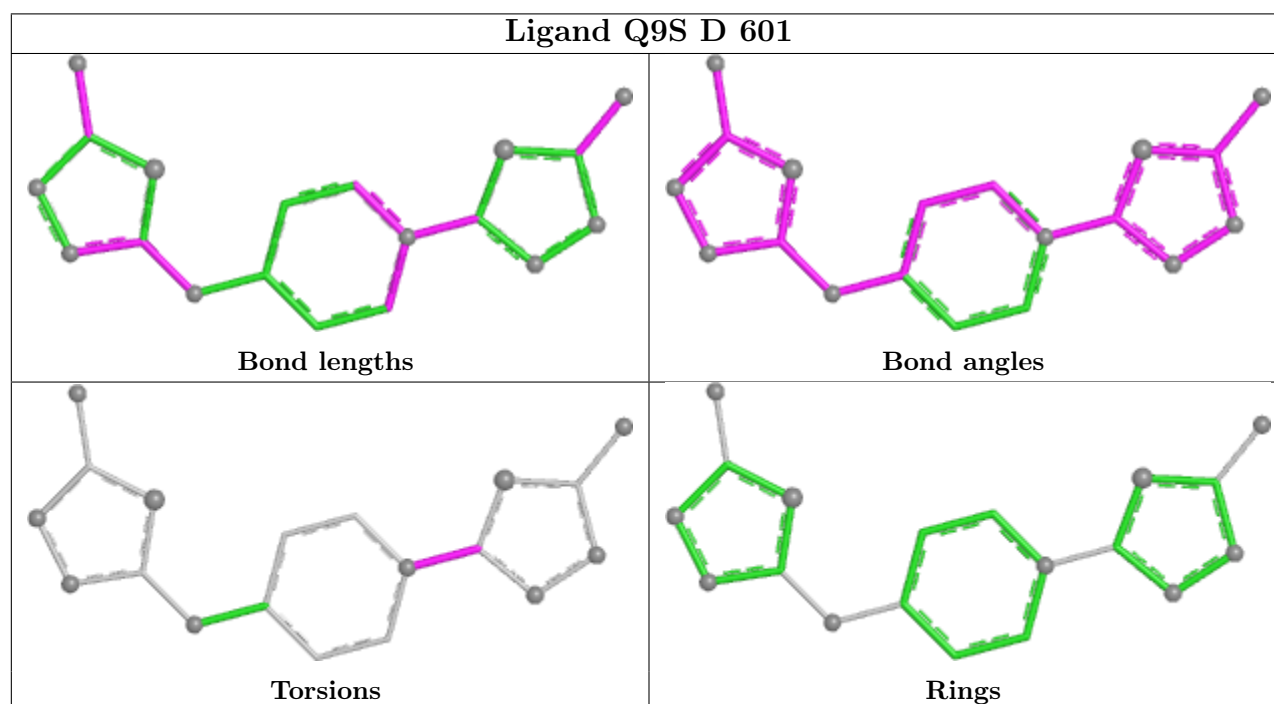
Mol	Chain	Res	Type	Atoms
2	D	601	Q9S	S37-C23-N03-C02
2	D	601	Q9S	S37-C23-N03-C04

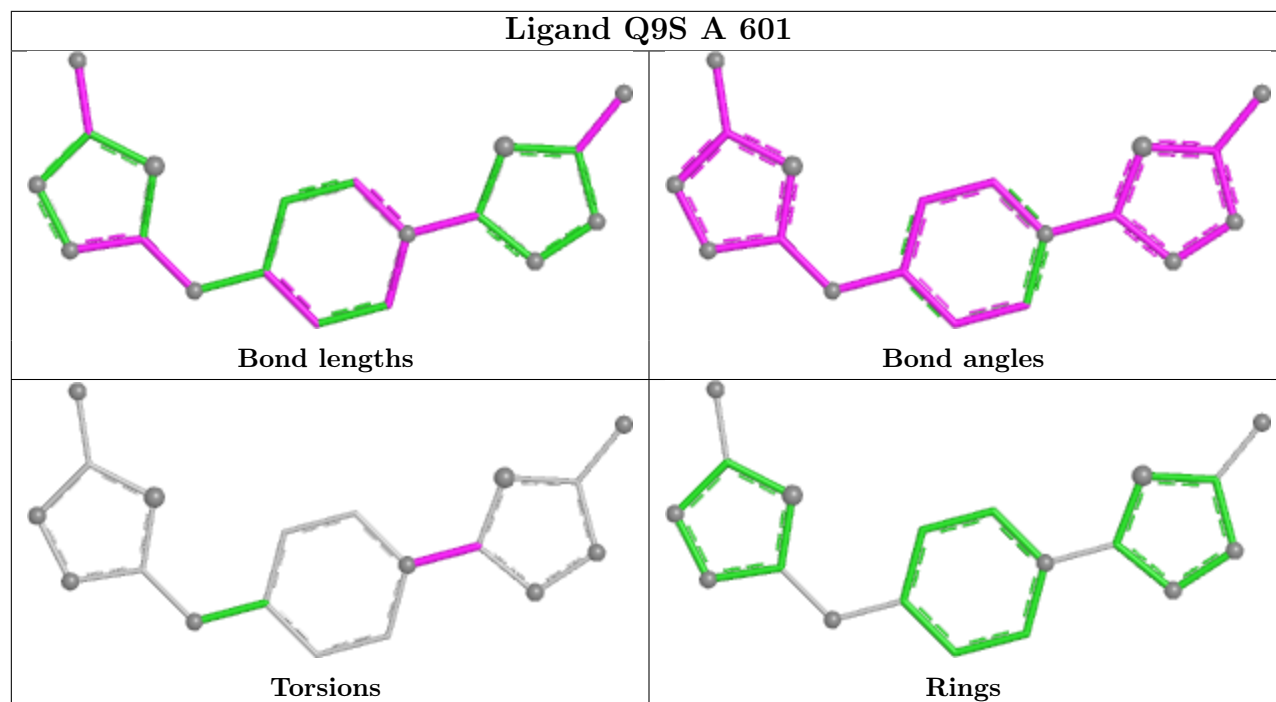
There are no ring outliers.

1 monomer is involved in 2 short contacts:

Mol	Chain	Res	Type	Clashes	Symm-Clashes
2	A	601	Q9S	2	0

The following is a two-dimensional graphical depiction of Mogul quality analysis of bond lengths, bond angles, torsion angles, and ring geometry for all instances of the Ligand of Interest. In addition, ligands with molecular weight > 250 and outliers as shown on the validation Tables will also be included. For torsion angles, if less than 5% of the Mogul distribution of torsion angles is within 10 degrees of the torsion angle in question, then that torsion angle is considered an outlier. Any bond that is central to one or more torsion angles identified as an outlier by Mogul will be highlighted in the graph. For rings, the root-mean-square deviation (RMSD) between the ring in question and similar rings identified by Mogul is calculated over all ring torsion angles. If the average RMSD is greater than 60 degrees and the minimal RMSD between the ring in question and any Mogul-identified rings is also greater than 60 degrees, then that ring is considered an outlier. The outliers are highlighted in purple. The color gray indicates Mogul did not find sufficient equivalents in the CSD to analyse the geometry.





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 [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	A	404/527 (76%)	-1.37	0 100 100	50, 88, 159, 246	0
1	B	398/527 (75%)	-1.38	0 100 100	52, 86, 163, 206	0
1	C	402/527 (76%)	-1.37	0 100 100	46, 88, 160, 230	0
1	D	397/527 (75%)	-1.35	0 100 100	51, 87, 165, 232	0
All	All	1601/2108 (75%)	-1.37	0 100 100	46, 87, 162, 246	0

There are no RSRZ outliers to report.

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.

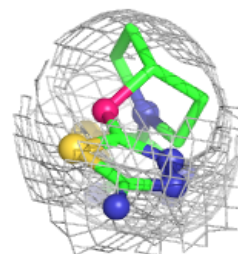
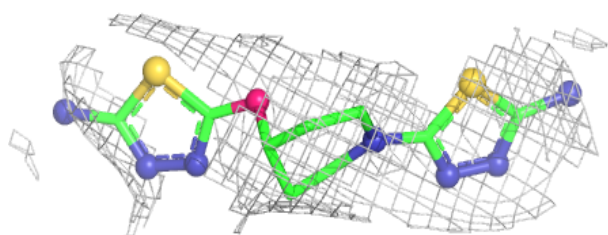
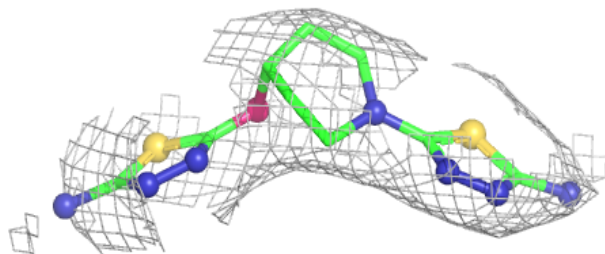
Mol	Type	Chain	Res	Atoms	RSCC	RSR	B-factors(Å ²)	Q<0.9
2	Q9S	A	601	19/19	1.00	0.02	58,84,103,110	0
2	Q9S	D	601	19/19	1.00	0.03	48,79,113,117	0

The following is a graphical depiction of the model fit to experimental electron density of all

instances of the Ligand of Interest. In addition, ligands with molecular weight > 250 and outliers as shown on the geometry validation Tables will also be included. Each fit is shown from different orientation to approximate a three-dimensional view.

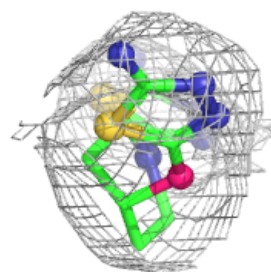
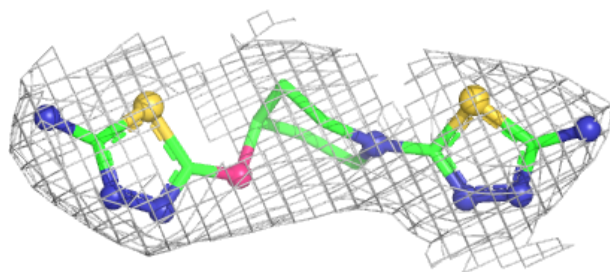
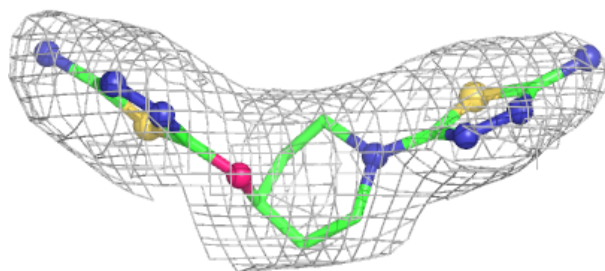
Electron density around Q9S A 601:

$2mF_o-DF_c$ (at 0.7 rmsd) in gray
 mF_o-DF_c (at 3 rmsd) in purple (negative)
and green (positive)



Electron density around Q9S D 601:

$2mF_o-DF_c$ (at 0.7 rmsd) in gray
 mF_o-DF_c (at 3 rmsd) in purple (negative)
and green (positive)



6.5 Other polymers [i](#)

There are no such residues in this entry.