



wwPDB X-ray Structure Validation Summary Report ⓘ

Mar 6, 2026 – 06:56 AM UTC

PDB ID : 3O98 / pdb_00003o98
Title : Glutathionylspermidine synthetase/amidase C59A complex with ADP and Gsp
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Deposited on : 2010-08-04
Resolution : 2.80 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

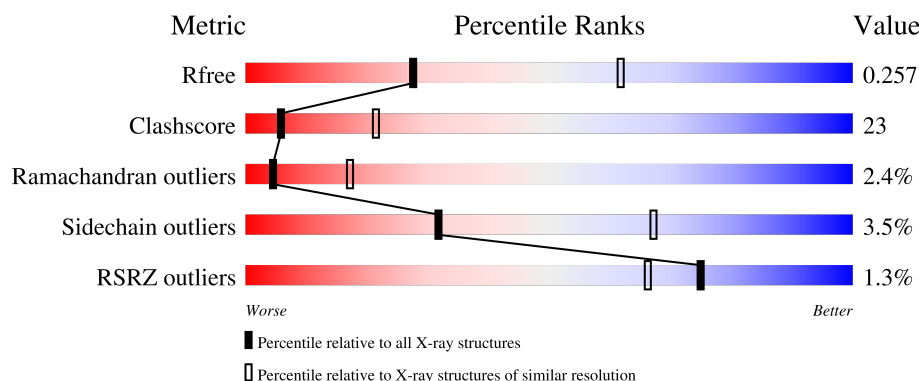
1 Overall quality at a glance

The following experimental techniques were used to determine the structure:

X-RAY DIFFRACTION

The reported resolution of this entry is 2.80 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))
R_{free}	180053	3866 (2.80-2.80)
Clashscore	190562	4276 (2.80-2.80)
Ramachandran outliers	187476	4196 (2.80-2.80)
Sidechain outliers	187428	4198 (2.80-2.80)
RSRZ outliers	180081	3869 (2.80-2.80)

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 $\leq 5\%$. 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	619	54% 37% 5% .
1	B	619	57% 37% . .

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	TS5	A	620	X	X	-	-

2 Entry composition [i](#)

There are 5 unique types of molecules in this entry. The entry contains 9968 atoms, of which 3 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.

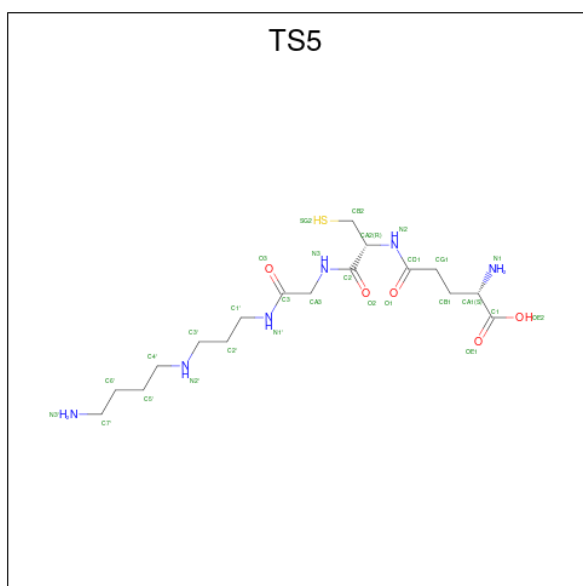
- Molecule 1 is a protein called Bifunctional glutathionylspermidine synthetase/amidase.

Mol	Chain	Residues	Atoms						ZeroOcc	AltConf	Trace
1	A	599	Total	C	H	N	O	S	0	0	0
			4823	3087	2	826	890	18			
1	B	603	Total	C	H	N	O	S	0	0	0
			4852	3104	1	830	899	18			

There are 2 discrepancies between the modelled and reference sequences:

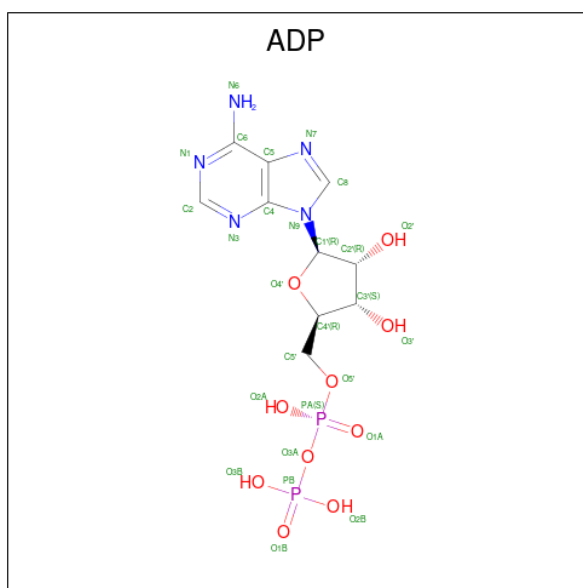
Chain	Residue	Modelled	Actual	Comment	Reference
A	59	ALA	CYS	engineered mutation	UNP P0AES0
B	59	ALA	CYS	engineered mutation	UNP P0AES0

- Molecule 2 is GLUTATHIONYLSPERMIDINE (CCD ID: TS5) (formula: $C_{17}H_{34}N_6O_5S$).



Mol	Chain	Residues	Atoms					ZeroOcc	AltConf
2	A	1	Total	C	N	O	S	0	0
			29	17	6	5	1		

- Molecule 3 is ADENOSINE-5'-DIPHOSPHATE (CCD ID: ADP) (formula: $C_{10}H_{15}N_5O_{10}P_2$).



Mol	Chain	Residues	Atoms					ZeroOcc	AltConf
3	A	1	Total	C	N	O	P	0	0
			27	10	5	10	2		
3	B	1	Total	C	N	O	P	0	0
			27	10	5	10	2		

- Molecule 4 is MAGNESIUM ION (CCD ID: MG) (formula: Mg).

Mol	Chain	Residues	Atoms		ZeroOcc	AltConf
4	A	2	Total	Mg	0	0
			2	2		
4	B	2	Total	Mg	0	0
			2	2		

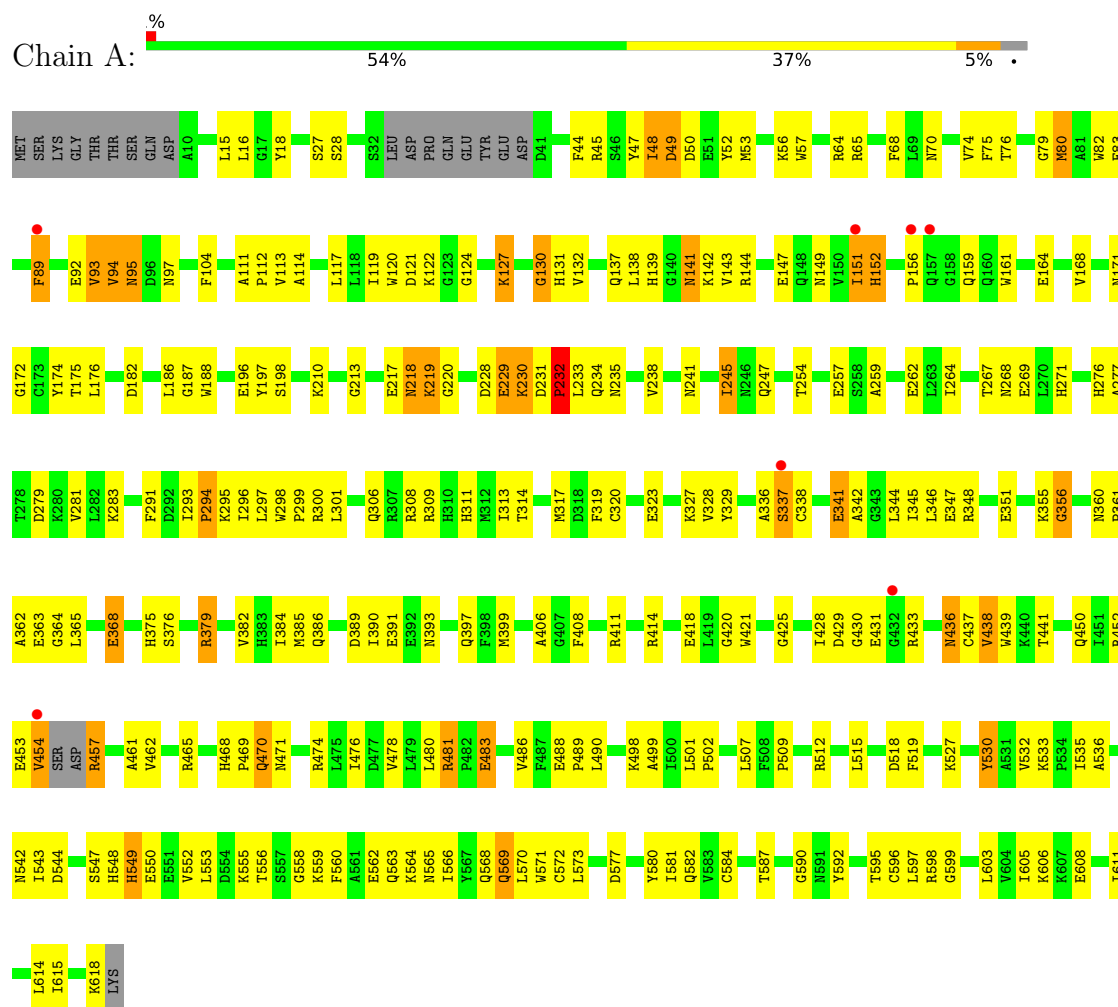
- Molecule 5 is water.

Mol	Chain	Residues	Atoms		ZeroOcc	AltConf
5	A	113	Total	O	0	0
			113	113		
5	B	93	Total	O	0	0
			93	93		

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: Bifunctional glutathionylspermidine synthetase/amidase



D96	N97	I98	L99		F104	F105	M106	G107	S108	P109	R110	A111	P112	V113		L117	L118	I119	W120	D121	K122	G123	G124	E125		T129	G130	H131	V132	A133	I134		Q137	L138	H139		K142	V143	R144		E147	Q148	W149	V150	I151	H152		L155		W161	T162	R163	E164	L165	F166	M167	V168	V169			
G172	N268	G173	Y174		D178	T179	F180	D181	D182	T183	T184	L185	L186	G187	W188		D194	T195	E196	Y197		Q201		I204	A205		G213	A214	R215		N218	K219	G220	Q221		K230		L233	Q234	N235		V238	Q239		G242		I245	N246	Q247		Y250		I255		A259	E260	Q261	E262	L263	I264	
I366	N367	E368		H375		M273	Y274	L275		D279	K388	D389	I390	E391	E392	N393	Y394	H395		M399	E400	Q401		Q405		T410		R414		E418		F319	C320	M321	D322		L326	K327	V328		D334		S337	C338	H339		T340	E341	A342		I345	L346	E347		G358	F359		A362	E363	G364	L365
Q470	N471		L475	L476	D477	V478	L479	L480	R481	P482	E483	V484	L485	V486	E487	E488	P489	L490	W491	T492		N497		L501	P502		H511	R512	Y513		T517	D518	F519	T520	Y521	N522	D523	E524	L525	V526		V532		T535	A536	G537	R538		N542	T543	D544		S547		E551	N552	L553	D554	K555		
T556	A561	E562	Q563		T566	T567	Q568	Q569	L570	N571		D577		Y580	L581	Q582	N583	C584		T587		Q590	N591	Y592		T595	C596	L597		R598	Q599	D600	E601	S602	L603		K606	R607	E608		I611		L614	I615	V616	W617	K618	LYS													

4 Data and refinement statistics

Property	Value	Source
Space group	P 1	Depositor
Cell constants a, b, c, α , β , γ	60.38Å 76.20Å 84.22Å 70.81° 74.37° 78.64°	Depositor
Resolution (Å)	30.00 – 2.80 30.00 – 2.82	Depositor EDS
% Data completeness (in resolution range)	(Not available) (30.00-2.80) 90.3 (30.00-2.82)	Depositor EDS
R_{merge}	0.10	Depositor
R_{sym}	(Not available)	Depositor
$\langle I/\sigma(I) \rangle$ ¹	3.54 (at 2.80Å)	Xtriage
Refinement program	CNS	Depositor
R, R_{free}	0.220 , 0.262 0.211 , 0.257	Depositor DCC
R_{free} test set	1554 reflections (4.96%)	wwPDB-VP
Wilson B-factor (Å ²)	49.5	Xtriage
Anisotropy	0.580	Xtriage
Bulk solvent k_{sol} (e/Å ³), B_{sol} (Å ²)	0.30 , 45.6	EDS
L-test for twinning ²	$\langle L \rangle = 0.50$, $\langle L^2 \rangle = 0.33$	Xtriage
Estimated twinning fraction	No twinning to report.	Xtriage
F_o, F_c correlation	0.93	EDS
Total number of atoms	9968	wwPDB-VP
Average B, all atoms (Å ²)	45.0	wwPDB-VP

Xtriage's analysis on translational NCS is as follows: *The largest off-origin peak in the Patterson function is 6.47% 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: TS5, ADP, MG

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	0.55	2/4944 (0.0%)	0.91	17/6713 (0.3%)
1	B	0.51	0/4975	0.89	9/6757 (0.1%)
All	All	0.53	2/9919 (0.0%)	0.90	26/13470 (0.2%)

All (2) bond length outliers are listed below:

Mol	Chain	Res	Type	Atoms	Z	Observed(Å)	Ideal(Å)
1	A	454	VAL	C-O	9.72	1.43	1.23
1	A	453	GLU	C-N	6.71	1.42	1.33

The worst 5 of 26 bond angle outliers are listed below:

Mol	Chain	Res	Type	Atoms	Z	Observed(°)	Ideal(°)
1	A	441	THR	N-CA-C	-11.04	99.84	113.97
1	B	441	THR	N-CA-C	-9.49	101.38	113.72
1	A	453	GLU	O-C-N	-9.03	112.55	122.12
1	B	93	VAL	N-CA-C	8.04	118.59	110.23
1	B	486	VAL	N-CA-C	6.90	118.41	108.48

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	4821	2	4697	247	0
1	B	4851	1	4722	201	0
2	A	29	0	31	6	0
3	A	27	0	12	2	0
3	B	27	0	12	1	0
4	A	2	0	0	0	0
4	B	2	0	0	0	0
5	A	113	0	0	1	0
5	B	93	0	0	3	0
All	All	9965	3	9474	444	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 23.

The worst 5 of 444 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:536:ALA:H	1:A:563:GLN:NE2	1.55	1.02
1:A:355:LYS:HD2	1:A:356:GLY:N	1.75	1.02
1:B:342:ALA:HA	1:B:346:LEU:HD12	1.46	0.97
1:A:89:PHE:HE1	1:A:269:GLU:HG3	1.32	0.94
1:A:355:LYS:HD2	1:A:356:GLY:H	1.29	0.91

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	593/619 (96%)	525 (88%)	54 (9%)	14 (2%)	4	17
1	B	599/619 (97%)	540 (90%)	44 (7%)	15 (2%)	4	16
All	All	1192/1238 (96%)	1065 (89%)	98 (8%)	29 (2%)	4	17

5 of 29 Ramachandran outliers are listed below:

Mol	Chain	Res	Type
1	A	127	LYS
1	A	341	GLU
1	B	150	VAL
1	A	94	VAL
1	A	356	GLY

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	510/529 (96%)	490 (96%)	20 (4%)	28	64
1	B	514/529 (97%)	498 (97%)	16 (3%)	35	70
All	All	1024/1058 (97%)	988 (96%)	36 (4%)	32	67

5 of 36 residues with a non-rotameric sidechain are listed below:

Mol	Chain	Res	Type
1	B	390	ILE
1	B	608	GLU
1	B	438	VAL
1	B	471	ASN
1	A	368	GLU

Sometimes sidechains can be flipped to improve hydrogen bonding and reduce clashes. 5 of 45 such sidechains are listed below:

Mol	Chain	Res	Type
1	B	268	ASN
1	B	395	HIS
1	B	286	ASN
1	B	352	GLN
1	B	468	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 ⓘ

Of 7 ligands modelled in this entry, 4 are monoatomic - leaving 3 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	ADP	A	3001	4	28,29,29	1.24	3 (10%)	43,45,45	1.04	3 (6%)
3	ADP	B	3002	4	28,29,29	1.23	3 (10%)	43,45,45	1.07	2 (4%)
2	TS5	A	620	-	27,28,28	4.57	15 (55%)	30,33,33	5.46	13 (43%)

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
3	ADP	A	3001	4	-	3/16/32/32	0/3/3/3
3	ADP	B	3002	4	-	3/16/32/32	0/3/3/3
2	TS5	A	620	-	1/1/6/10	11/34/34/34	-

The worst 5 of 21 bond length outliers are listed below:

Mol	Chain	Res	Type	Atoms	Z	Observed(Å)	Ideal(Å)
2	A	620	TS5	CB2-CA2	-12.05	1.40	1.53
2	A	620	TS5	C3-N1'	11.69	1.61	1.33
2	A	620	TS5	CD1-N2	6.76	1.48	1.34
2	A	620	TS5	O3-C3	6.29	1.35	1.23
2	A	620	TS5	CA2-C2	-5.60	1.38	1.52

The worst 5 of 18 bond angle outliers are listed below:

Mol	Chain	Res	Type	Atoms	Z	Observed(°)	Ideal(°)
2	A	620	TS5	CA2-CB2-SG2	14.55	130.56	114.16
2	A	620	TS5	CB2-CA2-C2	13.69	139.28	109.50
2	A	620	TS5	C1'-N1'-C3	-10.70	102.90	122.82
2	A	620	TS5	CB2-CA2-N2	-10.23	96.69	111.28
2	A	620	TS5	C2'-C1'-N1'	9.90	139.96	112.20

All (1) chirality outliers are listed below:

Mol	Chain	Res	Type	Atom
2	A	620	TS5	CA2

5 of 17 torsion outliers are listed below:

Mol	Chain	Res	Type	Atoms
2	A	620	TS5	C2-CA2-CB2-SG2
3	A	3001	ADP	PA-O3A-PB-O3B
3	B	3002	ADP	PA-O3A-PB-O3B
2	A	620	TS5	O2-C2-N3-CA3
2	A	620	TS5	C2'-C1'-N1'-C3

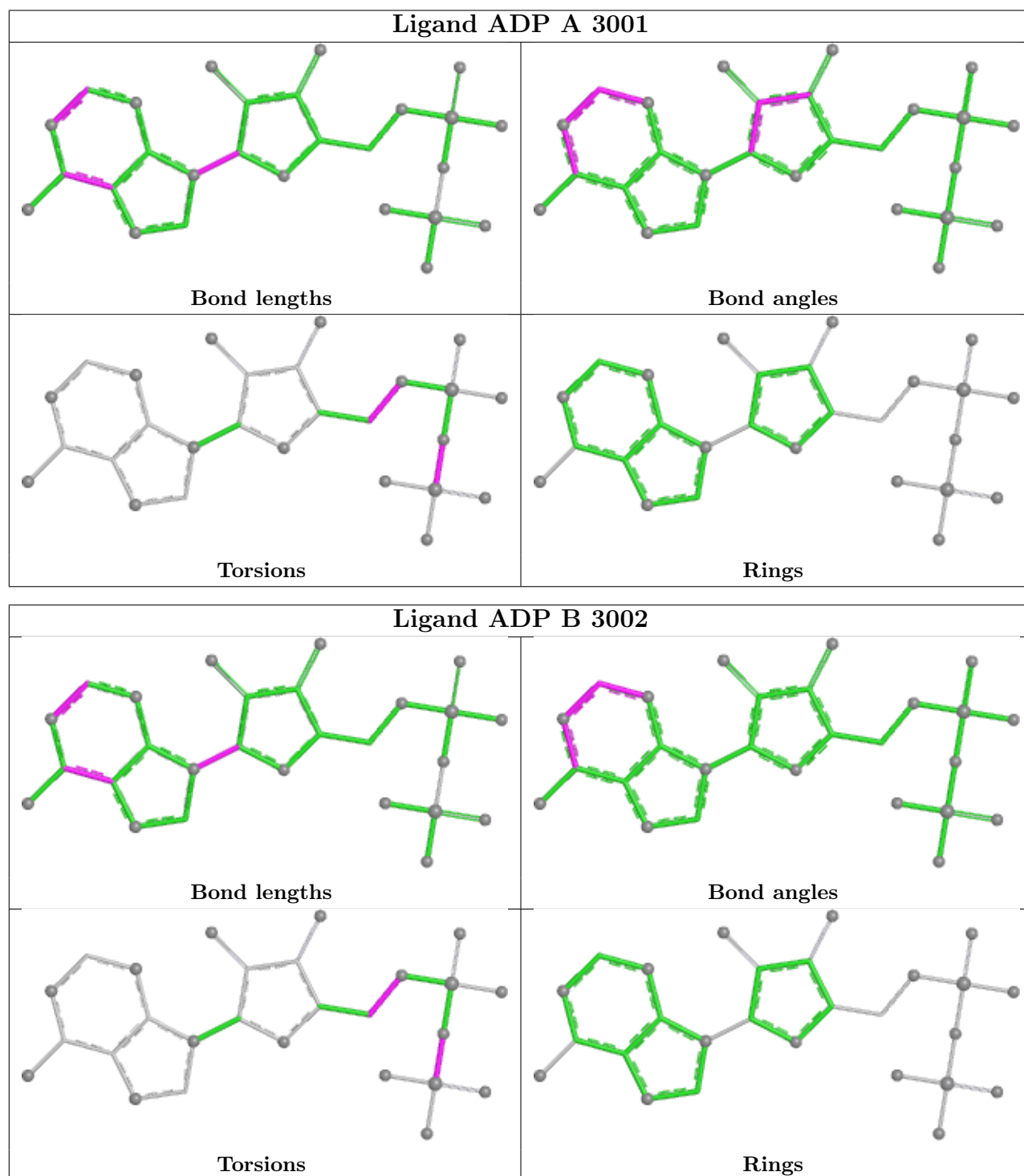
There are no ring outliers.

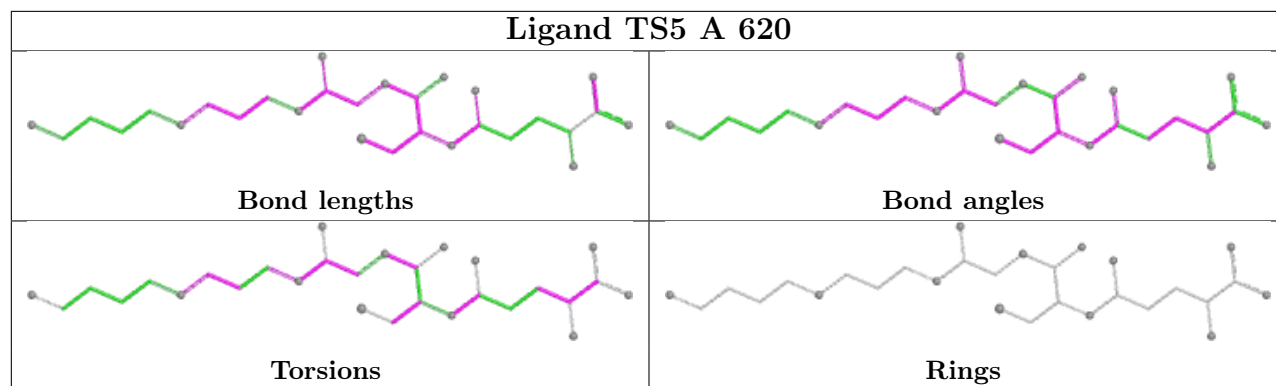
3 monomers are involved in 9 short contacts:

Mol	Chain	Res	Type	Clashes	Symm-Clashes
3	A	3001	ADP	2	0
3	B	3002	ADP	1	0
2	A	620	TS5	6	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	599/619 (96%)	-0.02	7 (1%) 76 68	17, 43, 65, 84	0
1	B	603/619 (97%)	0.05	9 (1%) 72 63	19, 46, 69, 86	0
All	All	1202/1238 (97%)	0.01	16 (1%) 75 66	17, 44, 67, 86	0

The worst 5 of 16 RSRZ outliers are listed below:

Mol	Chain	Res	Type	RSRZ
1	B	33	LEU	3.8
1	A	337	SER	3.6
1	B	32	SER	3.5
1	B	553	LEU	3.1
1	B	337	SER	3.0

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](#)

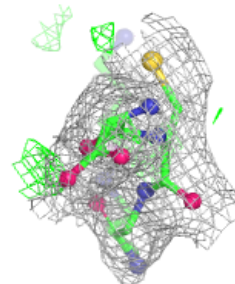
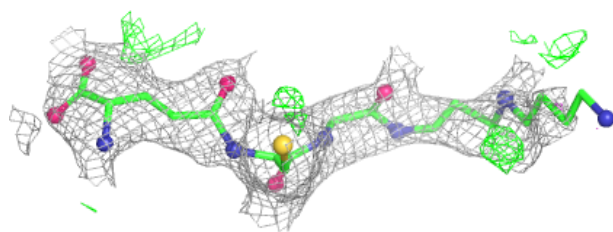
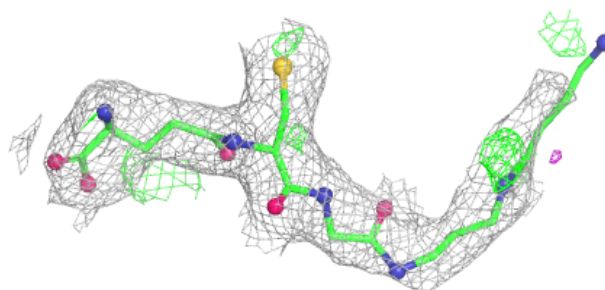
In the following table, the Atoms column lists the number of modelled atoms in the group and the number defined in the chemical component dictionary. The B-factors column lists the minimum, median, 95th percentile and maximum values of B factors of atoms in the group. The column labelled ‘Q< 0.9’ lists 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	TS5	A	620	29/29	0.84	0.15	39,45,75,78	0
3	ADP	A	3001	27/27	0.97	0.07	30,33,34,36	0
3	ADP	B	3002	27/27	0.98	0.06	32,39,40,42	0
4	MG	A	4000	1/1	0.98	0.04	37,37,37,37	0
4	MG	B	6000	1/1	0.99	0.02	39,39,39,39	0
4	MG	A	5000	1/1	1.00	0.02	32,32,32,32	0
4	MG	B	7000	1/1	1.00	0.02	34,34,34,34	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.

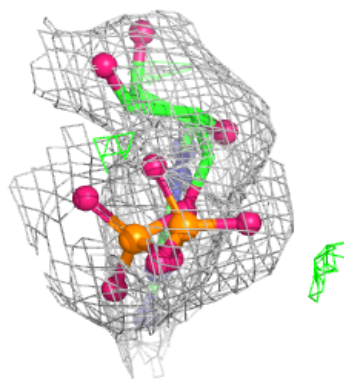
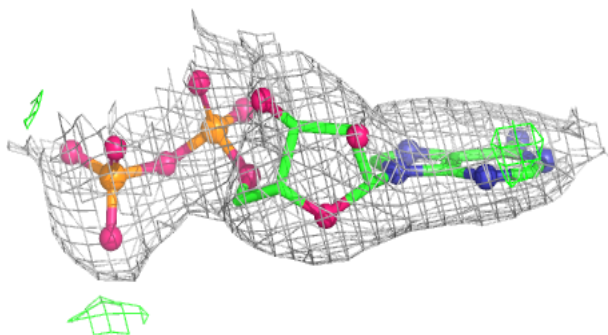
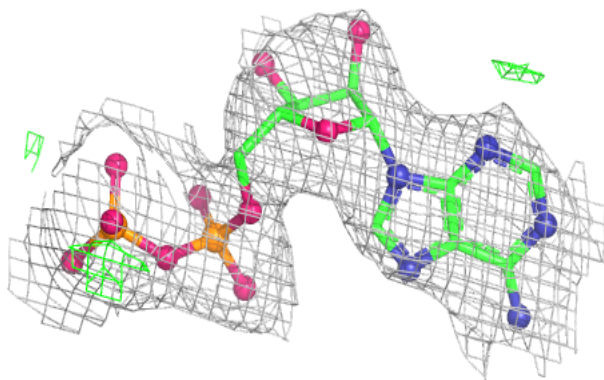
Electron density around TS5 A 620:

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

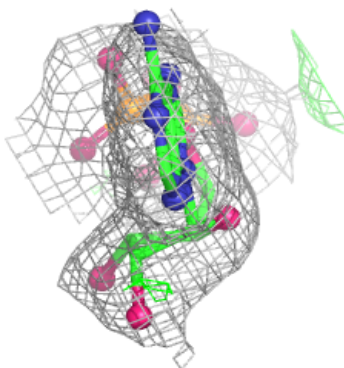
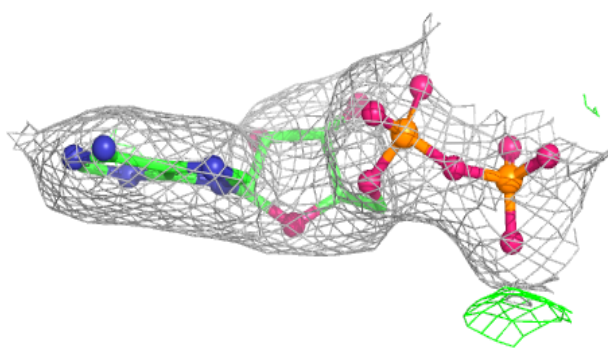
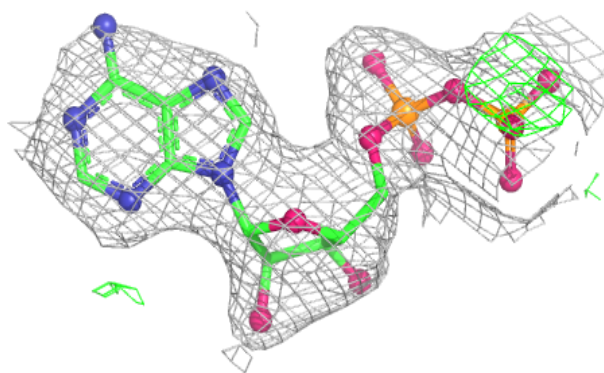


Electron density around ADP A 3001:

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

**Electron density around ADP B 3002:**

$2mF_o-DF_c$ (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.