



Full wwPDB X-ray Structure Validation Report ⓘ

Mar 5, 2026 – 11:40 AM UTC

PDB ID : 4QBG / pdb_00004qbg
Title : Crystal structure of a stable adenylate kinase variant AKlse4
Authors : Moon, S.; Bae, E.
Deposited on : 2014-05-08
Resolution : 1.37 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
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

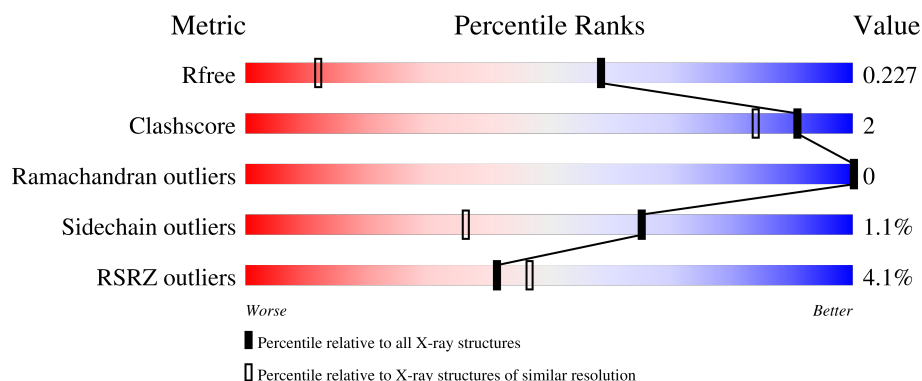
1 Overall quality at a glance

The following experimental techniques were used to determine the structure:

X-RAY DIFFRACTION

The reported resolution of this entry is 1.37 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	4403 (1.40-1.36)
Clashscore	190562	4528 (1.40-1.36)
Ramachandran outliers	187476	4459 (1.40-1.36)
Sidechain outliers	187428	4458 (1.40-1.36)
RSRZ outliers	180081	4399 (1.40-1.36)

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	B	217	4% 88% 12%

2 Entry composition

There are 5 unique types of molecules in this entry. The entry contains 1997 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 Adenylate kinase.

Mol	Chain	Residues	Atoms					ZeroOcc	AltConf	Trace
1	B	217	Total	C	N	O	S	0	0	0
			1706	1065	301	327	13			

There are 38 discrepancies between the modelled and reference sequences:

Chain	Residue	Modelled	Actual	Comment	Reference
B	3	ILE	LEU	engineered mutation	UNP P16304
B	17	ALA	GLY	engineered mutation	UNP P16304
B	22	ALA	GLU	engineered mutation	UNP P16304
B	23	LYS	ASP	engineered mutation	UNP P16304
B	69	ARG	LYS	engineered mutation	UNP P16304
B	73	SER	GLY	engineered mutation	UNP P16304
B	75	SER	ASP	engineered mutation	UNP P16304
B	103	MET	TYR	engineered mutation	UNP P16304
B	105	ARG	LYS	engineered mutation	UNP P16304
B	106	LYS	PRO	engineered mutation	UNP P16304
B	107	LEU	ILE	engineered mutation	UNP P16304
B	108	GLU	ASP	engineered mutation	UNP P16304
B	109	HIS	TYR	engineered mutation	UNP P16304
B	112	HIS	ASN	engineered mutation	UNP P16304
B	116	ARG	ASP	engineered mutation	UNP P16304
B	117	GLN	LYS	engineered mutation	UNP P16304
B	118	GLU	ASP	engineered mutation	UNP P16304
B	119	GLU	VAL	engineered mutation	UNP P16304
B	169	ALA	SER	engineered mutation	UNP P16304
B	179	MET	THR	engineered mutation	UNP P16304
B	180	ALA	GLN	engineered mutation	UNP P16304
B	184	ALA	ASP	engineered mutation	UNP P16304
B	187	ASP	SER	engineered mutation	UNP P16304
B	188	SER	GLU	engineered mutation	UNP P16304
B	190	GLU	GLY	engineered mutation	UNP P16304
B	191	VAL	TYR	engineered mutation	UNP P16304
B	193	ARG	ALA	engineered mutation	UNP P16304

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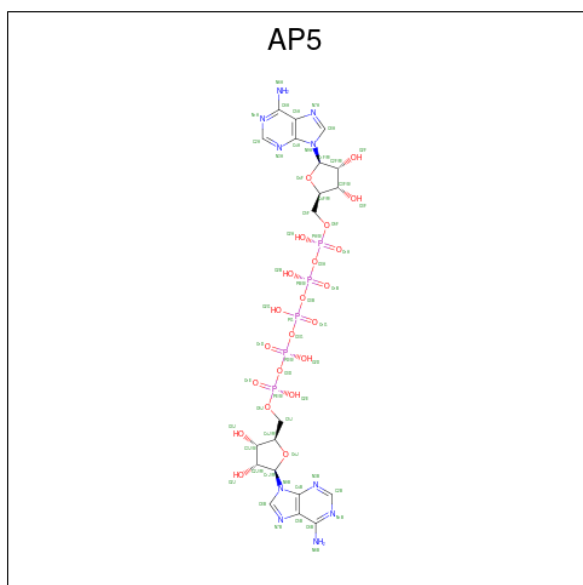
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Chain	Residue	Modelled	Actual	Comment	Reference
B	201	MET	ILE	engineered mutation	UNP P16304
B	202	GLU	GLN	engineered mutation	UNP P16304
B	203	LYS	ASP	engineered mutation	UNP P16304
B	205	PHE	TYR	engineered mutation	UNP P16304
B	206	LYS	ALA	engineered mutation	UNP P16304
B	208	LEU	VAL	engineered mutation	UNP P16304
B	209	ARG	LYS	engineered mutation	UNP P16304
B	210	GLU	ASP	engineered mutation	UNP P16304
B	213	GLN	GLY	engineered mutation	UNP P16304
B	216	ALA	LYS	engineered mutation	UNP P16304
B	217	ARG	LYS	engineered mutation	UNP P16304

- Molecule 2 is ZINC ION (CCD ID: ZN) (formula: Zn).

Mol	Chain	Residues	Atoms	ZeroOcc	AltConf
2	B	1	Total Zn 1 1	0	0

- Molecule 3 is BIS(ADENOSINE)-5'-PENTAPHOSPHATE (CCD ID: AP5) (formula: C₂₀H₂₉N₁₀O₂₂P₅).



Mol	Chain	Residues	Atoms	ZeroOcc	AltConf
3	B	1	Total C N O P 57 20 10 22 5	0	0

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

Mol	Chain	Residues	Atoms		ZeroOcc	AltConf
4	B	1	Total 1	Mg 1	0	0

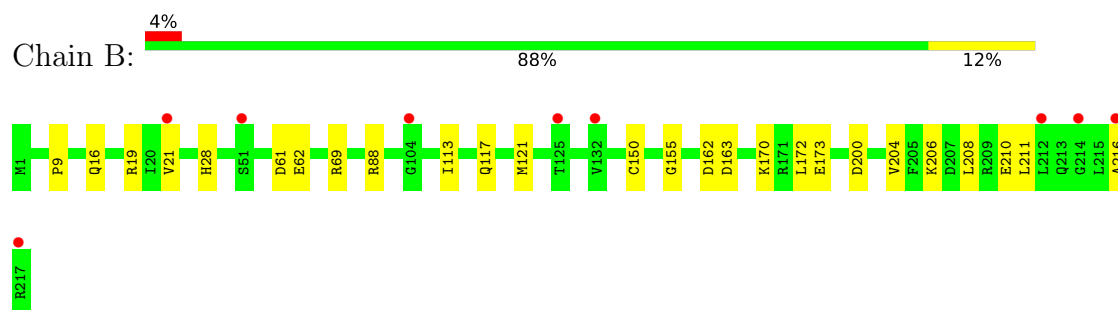
- Molecule 5 is water.

Mol	Chain	Residues	Atoms		ZeroOcc	AltConf
5	B	232	Total 232	O 232	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: Adenylate kinase



4 Data and refinement statistics

Property	Value	Source
Space group	C 1 2 1	Depositor
Cell constants a, b, c, α , β , γ	68.82Å 71.02Å 45.55Å 90.00° 95.13° 90.00°	Depositor
Resolution (Å)	49.32 – 1.37 49.32 – 1.37	Depositor EDS
% Data completeness (in resolution range)	96.7 (49.32-1.37) 96.7 (49.32-1.37)	Depositor EDS
R_{merge}	(Not available)	Depositor
R_{sym}	(Not available)	Depositor
$\langle I/\sigma(I) \rangle$ ¹	2.15 (at 1.37Å)	Xtriage
Refinement program	REFMAC 5.8.0049	Depositor
R, R_{free}	0.179 , 0.220 0.189 , 0.227	Depositor DCC
R_{free} test set	2265 reflections (4.96%)	wwPDB-VP
Wilson B-factor (Å ²)	19.0	Xtriage
Anisotropy	0.114	Xtriage
Bulk solvent k_{sol} (e/Å ³), B_{sol} (Å ²)	0.38 , 41.1	EDS
L-test for twinning ²	$\langle L \rangle = 0.49$, $\langle L^2 \rangle = 0.33$	Xtriage
Estimated twinning fraction	No twinning to report.	Xtriage
F_o, F_c correlation	0.97	EDS
Total number of atoms	1997	wwPDB-VP
Average B, all atoms (Å ²)	26.0	wwPDB-VP

Xtriage's analysis on translational NCS is as follows: *The largest off-origin peak in the Patterson function is 8.12% 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: AP5, MG, 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	B	1.62	9/1729 (0.5%)	1.44	8/2321 (0.3%)

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	B	0	1

All (9) bond length outliers are listed below:

Mol	Chain	Res	Type	Atoms	Z	Observed(Å)	Ideal(Å)
1	B	150	CYS	N-CA	-7.26	1.36	1.46
1	B	155	GLY	CA-C	6.67	1.58	1.52
1	B	121	MET	C-O	-6.24	1.16	1.24
1	B	113	ILE	CA-C	-6.05	1.47	1.53
1	B	19	ARG	C-N	5.74	1.41	1.33
1	B	62	GLU	C-O	5.61	1.30	1.24
1	B	163	ASP	CA-C	5.44	1.60	1.52
1	B	61	ASP	C-O	5.41	1.30	1.24
1	B	170	LYS	N-CA	-5.36	1.40	1.46

All (8) bond angle outliers are listed below:

Mol	Chain	Res	Type	Atoms	Z	Observed(°)	Ideal(°)
1	B	121	MET	CG-SD-CE	-6.41	86.81	100.90
1	B	69	ARG	NE-CZ-NH2	-6.01	113.79	119.20
1	B	16	GLN	CA-C-O	5.81	126.58	120.42
1	B	210	GLU	CA-CB-CG	-5.76	102.58	114.10

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Mol	Chain	Res	Type	Atoms	Z	Observed(°)	Ideal(°)
1	B	204	VAL	N-CA-C	-5.53	105.11	110.42
1	B	170	LYS	N-CA-C	5.50	116.96	111.07
1	B	162	ASP	N-CA-C	5.31	119.74	113.16
1	B	200	ASP	N-CA-CB	5.11	117.38	110.38

There are no chirality outliers.

All (1) planarity outliers are listed below:

Mol	Chain	Res	Type	Group
1	B	88	ARG	Sidechain

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	B	1706	0	1725	6	0
2	B	1	0	0	0	0
3	B	57	0	24	0	0
4	B	1	0	0	0	0
5	B	232	0	0	0	0
All	All	1997	0	1749	6	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 2.

All (6) 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:B:117:GLN:HG3	1:B:172:LEU:HD13	1.75	0.68
1:B:21:VAL:HG11	1:B:28:HIS:HB2	1.93	0.51
1:B:211:LEU:HD23	1:B:216:ALA:HB3	1.94	0.49
1:B:117:GLN:CG	1:B:172:LEU:HD13	2.40	0.49
1:B:208:LEU:HA	1:B:208:LEU:HD23	1.84	0.44
1:B:9:PRO:HD2	1:B:172:LEU:HD23	1.99	0.44

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	B	215/217 (99%)	215 (100%)	0	0	100	100

There are no Ramachandran outliers to report.

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	B	184/184 (100%)	182 (99%)	2 (1%)	65	36

All (2) residues with a non-rotameric sidechain are listed below:

Mol	Chain	Res	Type
1	B	173	GLU
1	B	206	LYS

Sometimes sidechains can be flipped to improve hydrogen bonding and reduce clashes. All (2) such sidechains are listed below:

Mol	Chain	Res	Type
1	B	178	GLN
1	B	213	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 3 ligands modelled in this entry, 2 are monoatomic - leaving 1 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	AP5	B	302	4	62,62,62	1.89	9 (14%)	89,98,98	1.77	21 (23%)

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	AP5	B	302	4	-	7/44/76/76	0/6/6/6

All (9) bond length outliers are listed below:

Mol	Chain	Res	Type	Atoms	Z	Observed(Å)	Ideal(Å)
3	B	302	AP5	PD-O3G	-9.54	1.49	1.59
3	B	302	AP5	PA-O1A	-3.37	1.39	1.50
3	B	302	AP5	PE-O2E	-3.32	1.40	1.55
3	B	302	AP5	C8A-N9A	-3.22	1.32	1.37
3	B	302	AP5	PD-O3D	2.44	1.62	1.59
3	B	302	AP5	PB-O3A	2.44	1.62	1.59
3	B	302	AP5	C5B-N7B	2.26	1.43	1.39
3	B	302	AP5	PE-O5J	2.19	1.68	1.59

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Mol	Chain	Res	Type	Atoms	Z	Observed(Å)	Ideal(Å)
3	B	302	AP5	C4B-N9B	-2.05	1.33	1.37

All (21) bond angle outliers are listed below:

Mol	Chain	Res	Type	Atoms	Z	Observed(°)	Ideal(°)
3	B	302	AP5	C5B-C4B-N3B	-5.49	119.16	126.72
3	B	302	AP5	C2J-C3J-C4J	-4.43	94.04	102.61
3	B	302	AP5	O2D-PD-O1D	3.86	130.42	112.44
3	B	302	AP5	N6A-C6A-N1A	3.55	126.29	118.38
3	B	302	AP5	N3B-C4B-N9B	3.51	133.14	127.17
3	B	302	AP5	O2D-PD-O3G	-3.45	97.95	107.27
3	B	302	AP5	C5A-C4A-N3A	-3.40	122.04	126.72
3	B	302	AP5	C6B-C5B-C4B	3.27	121.64	117.18
3	B	302	AP5	C4A-C5A-N7A	-2.96	107.19	110.58
3	B	302	AP5	C2B-N1B-C6B	-2.71	114.27	118.73
3	B	302	AP5	N3A-C2A-N1A	-2.65	124.57	128.58
3	B	302	AP5	O2E-PE-O3D	2.62	114.36	107.27
3	B	302	AP5	C2A-N1A-C6A	2.58	122.97	118.73
3	B	302	AP5	C3J-C2J-C1J	2.25	105.71	101.46
3	B	302	AP5	O3A-PB-O1B	-2.15	104.23	110.70
3	B	302	AP5	N3A-C4A-N9A	2.14	130.80	127.17
3	B	302	AP5	C5A-C6A-N6A	-2.13	118.02	123.29
3	B	302	AP5	O2B-PB-O1B	2.12	122.32	112.44
3	B	302	AP5	O4J-C4J-C3J	2.09	109.31	105.15
3	B	302	AP5	O3B-PG-O1G	-2.07	104.48	110.70
3	B	302	AP5	C4B-N9B-C8B	2.04	107.88	105.74

There are no chirality outliers.

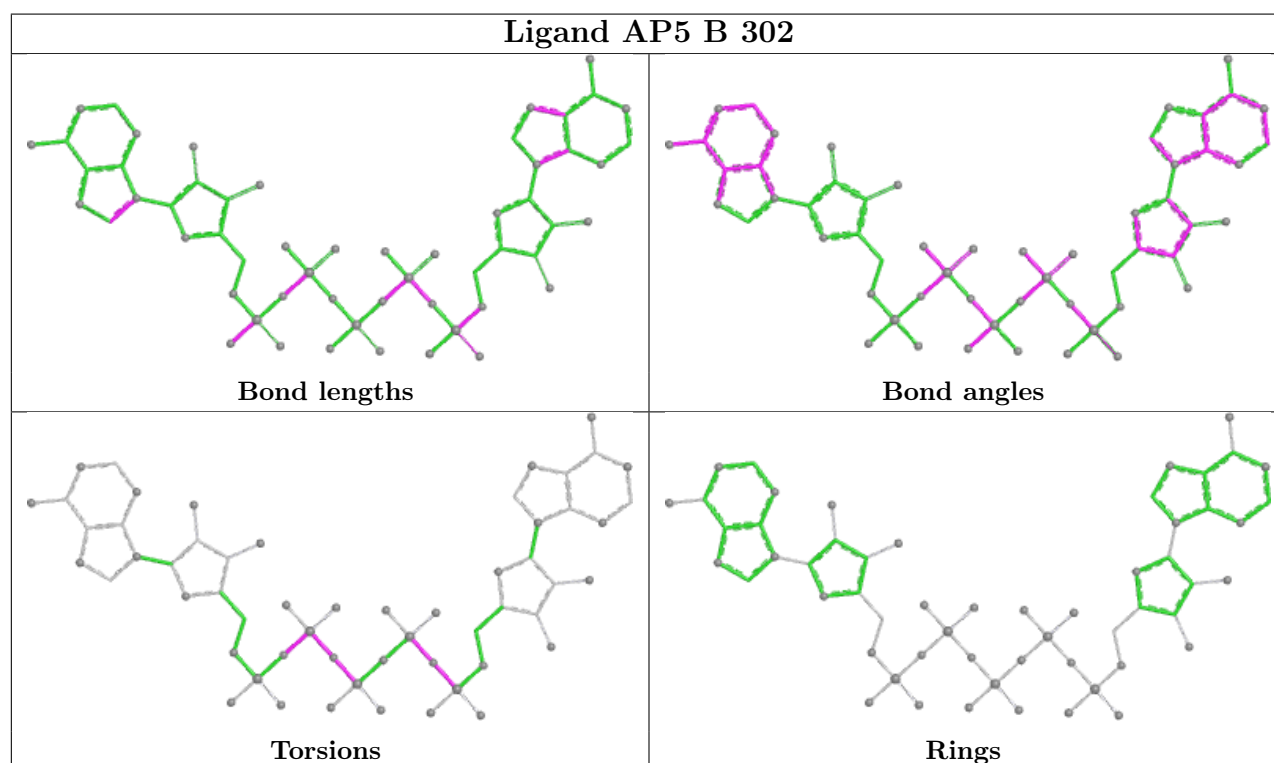
All (7) torsion outliers are listed below:

Mol	Chain	Res	Type	Atoms
3	B	302	AP5	PG-O3B-PB-O1B
3	B	302	AP5	PD-O3D-PE-O1E
3	B	302	AP5	PG-O3B-PB-O2B
3	B	302	AP5	PD-O3D-PE-O2E
3	B	302	AP5	PA-O3A-PB-O2B
3	B	302	AP5	PB-O3B-PG-O2G
3	B	302	AP5	PE-O3D-PD-O2D

There are no ring outliers.

No monomer is involved in short contacts.

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	B	217/217 (100%)	0.56	9 (4%)	41 47	13, 23, 37, 50	0

All (9) RSRZ outliers are listed below:

Mol	Chain	Res	Type	RSRZ
1	B	125	THR	2.9
1	B	214	GLY	2.8
1	B	132	VAL	2.7
1	B	217	ARG	2.6
1	B	216	ALA	2.5
1	B	51	SER	2.2
1	B	212	LEU	2.2
1	B	21	VAL	2.1
1	B	104	GLY	2.0

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](#)

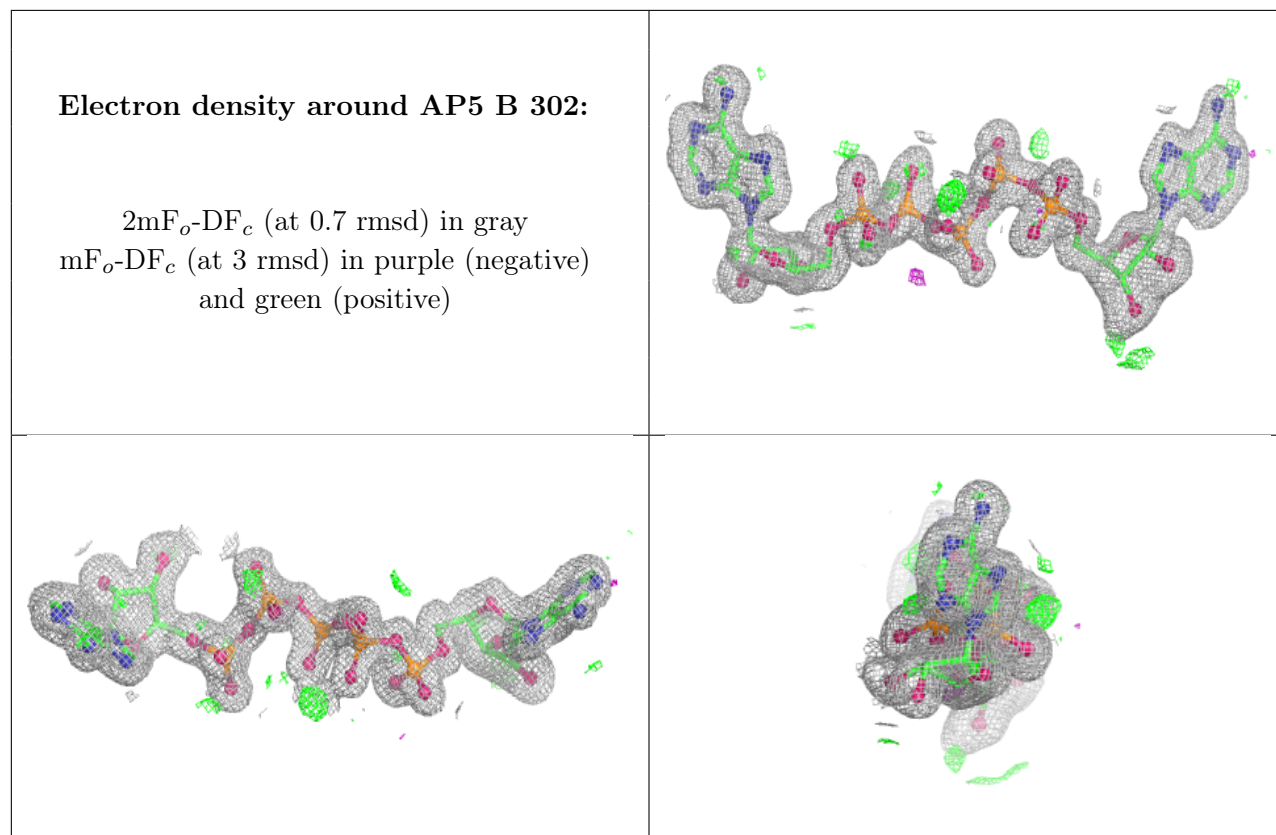
There are no oligosaccharides in this entry.

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	ZN	B	301	1/1	0.96	0.09	27,27,27,27	0
3	AP5	B	302	57/57	0.98	0.06	15,18,24,25	0
4	MG	B	303	1/1	0.99	0.10	19,19,19,19	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.



6.5 Other polymers ⓘ

There are no such residues in this entry.