



# Full wwPDB X-ray Structure Validation Report ⓘ

May 16, 2020 – 12:02 am BST

PDB ID : 6TWF  
Title : Human CD73 (ecto 5'-nucleotidase) in complex with PSB12604 (an AOPCP derivative, compound 21 in publication) in the closed state  
Authors : Pippel, J.; Strater, N.  
Deposited on : 2020-01-13  
Resolution : 2.50 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](mailto: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.

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The following versions of software and data (see [references ⓘ](#)) were used in the production of this report:

MolProbity : 4.02b-467  
Mogul : 1.8.5 (274361), CSD as541be (2020)  
Xtriage (Phenix) : 1.13  
EDS : 2.11  
buster-report : 1.1.7 (2018)  
Percentile statistics : 20191225.v01 (using entries in the PDB archive December 25th 2019)  
Refmac : 5.8.0158  
CCP4 : 7.0.044 (Gargrove)  
Ideal geometry (proteins) : Engh & Huber (2001)  
Ideal geometry (DNA, RNA) : Parkinson et al. (1996)  
Validation Pipeline (wwPDB-VP) : 2.11

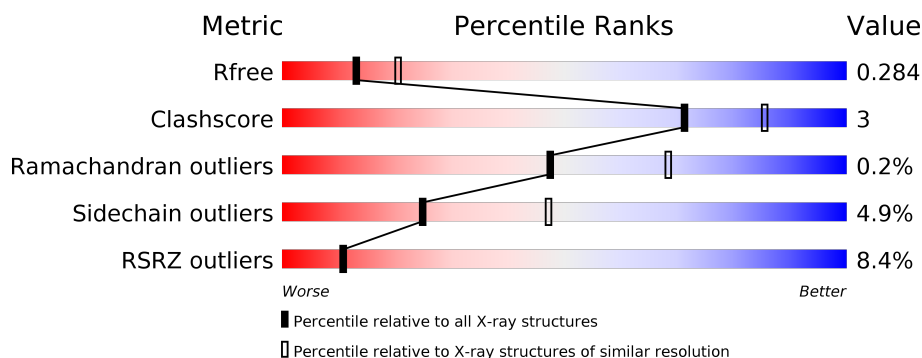
# 1 Overall quality at a glance

The following experimental techniques were used to determine the structure:

## *X-RAY DIFFRACTION*

The reported resolution of this entry is 2.50 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))
$R_{free}$	130704	4661 (2.50-2.50)
Clashscore	141614	5346 (2.50-2.50)
Ramachandran outliers	138981	5231 (2.50-2.50)
Sidechain outliers	138945	5233 (2.50-2.50)
RSRZ outliers	127900	4559 (2.50-2.50)

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 on the lower bar indicate the fraction of residues that contain outliers for  $\geq 3$ , 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	532	<div> <div>8%</div> <div>88%</div> <div>9%</div> <div>..</div> </div>

## 2 Entry composition

There are 5 unique types of molecules in this entry. The entry contains 8151 atoms, of which 4057 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 5'-nucleotidase.

Mol	Chain	Residues	Atoms						ZeroOcc	AltConf	Trace
1	A	521	Total	C	H	N	O	S	0	1	0
			8089	2575	4035	691	769	19			

There are 14 discrepancies between the modelled and reference sequences:

Chain	Residue	Modelled	Actual	Comment	Reference
A	26	MET	-	initiating methionine	UNP P21589
A	53	ASP	ASN	engineered mutation	UNP P21589
A	311	ASP	ASN	engineered mutation	UNP P21589
A	333	ASP	ASN	engineered mutation	UNP P21589
A	376	ALA	THR	engineered mutation	UNP P21589
A	403	ASP	ASN	engineered mutation	UNP P21589
A	550	LEU	-	expression tag	UNP P21589
A	551	GLU	-	expression tag	UNP P21589
A	552	HIS	-	expression tag	UNP P21589
A	553	HIS	-	expression tag	UNP P21589
A	554	HIS	-	expression tag	UNP P21589
A	555	HIS	-	expression tag	UNP P21589
A	556	HIS	-	expression tag	UNP P21589
A	557	HIS	-	expression tag	UNP P21589

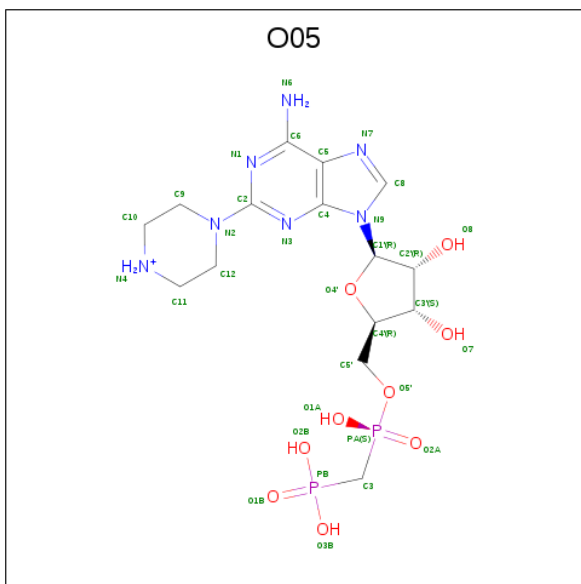
- Molecule 2 is ZINC ION (three-letter code: ZN) (formula: Zn).

Mol	Chain	Residues	Atoms		ZeroOcc	AltConf
2	A	2	Total	Zn	0	0
			2	2		

- Molecule 3 is CALCIUM ION (three-letter code: CA) (formula: Ca).

Mol	Chain	Residues	Atoms		ZeroOcc	AltConf
3	A	1	Total	Ca	0	0
			1	1		

- Molecule 4 is [[(2 {R},3 {S},4 {R},5 {R})-5-(6-azanyl-2-piperazin-4-ium-1-yl-purin-9-yl)-3,4-bis(oxidanyl)oxolan-2-yl]methoxy-oxidanyl-phosphoryl]methylphosphonic acid (three-letter code: O05) (formula: C<sub>15</sub>H<sub>26</sub>N<sub>7</sub>O<sub>9</sub>P<sub>2</sub>) (labeled as "Ligand of Interest" by author).



Mol	Chain	Residues	Atoms						ZeroOcc	AltConf
4	A	1	Total	C	H	N	O	P	0	0
			55	15	22	7	9	2		

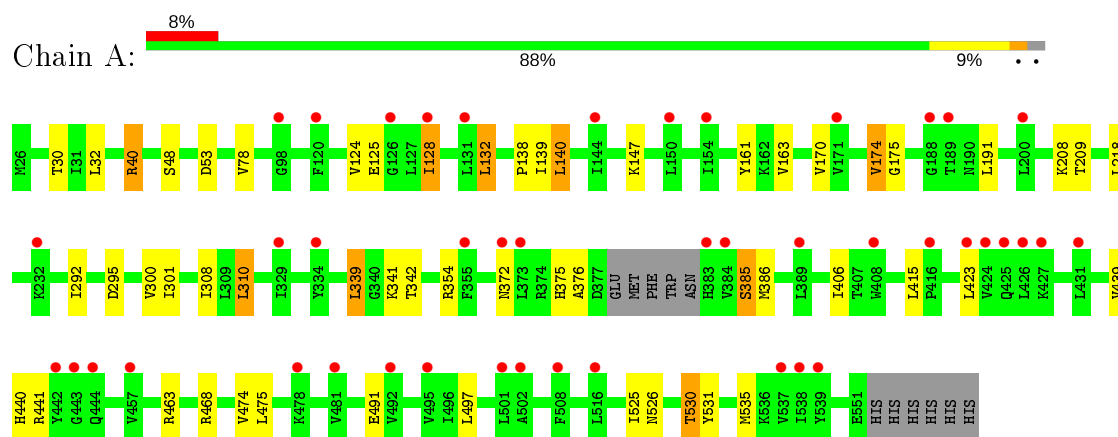
- Molecule 5 is water.

Mol	Chain	Residues	Atoms		ZeroOcc	AltConf
5	A	4	Total	O	0	0
			4	4		

### 3 Residue-property plots [i](#)

These plots are drawn for all protein, RNA and DNA 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: 5'-nucleotidase



## 4 Data and refinement statistics

Property	Value	Source
Space group	C 2 2 21	Depositor
Cell constants a, b, c, $\alpha$ , $\beta$ , $\gamma$	54.45Å 97.22Å 234.37Å 90.00° 90.00° 90.00°	Depositor
Resolution (Å)	47.60 – 2.50 47.60 – 2.50	Depositor EDS
% Data completeness (in resolution range)	95.4 (47.60-2.50) 95.4 (47.60-2.50)	Depositor EDS
$R_{merge}$	0.20	Depositor
$R_{sym}$	(Not available)	Depositor
$\langle I/\sigma(I) \rangle$ <sup>1</sup>	1.32 (at 2.51Å)	Xtriage
Refinement program	BUSTER 2.10.1	Depositor
R, $R_{free}$	0.220 , 0.262 0.243 , 0.284	Depositor DCC
$R_{free}$ test set	565 reflections (2.68%)	wwPDB-VP
Wilson B-factor (Å <sup>2</sup> )	55.0	Xtriage
Anisotropy	1.246	Xtriage
Bulk solvent $k_{sol}$ (e/Å <sup>3</sup> ), $B_{sol}$ (Å <sup>2</sup> )	0.33 , 61.5	EDS
L-test for twinning <sup>2</sup>	$\langle  L  \rangle = 0.48$ , $\langle L^2 \rangle = 0.31$	Xtriage
Estimated twinning fraction	0.034 for 1/2*h-1/2*k,-3/2*h-1/2*k,-l 0.054 for 1/2*h+1/2*k,3/2*h-1/2*k,-l	Xtriage
$F_o, F_c$ correlation	0.94	EDS
Total number of atoms	8151	wwPDB-VP
Average B, all atoms (Å <sup>2</sup> )	108.0	wwPDB-VP

Xtriage's analysis on translational NCS is as follows: *The largest off-origin peak in the Patterson function is 5.07% of the height of the origin peak. No significant pseudotranslation is detected.*

<sup>1</sup>Intensities estimated from amplitudes.

<sup>2</sup>Theoretical 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: O05, ZN, 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	0.49	0/4152	0.72	1/5621 (0.0%)

There are no bond length outliers.

All (1) bond angle outliers are listed below:

Mol	Chain	Res	Type	Atoms	Z	Observed( $^{\circ}$ )	Ideal( $^{\circ}$ )
1	A	354	ARG	CG-CD-NE	6.00	124.39	111.80

There are no chirality outliers.

There are no planarity outliers.

### 5.2 Too-close contacts [i](#)

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	4054	4035	4025	28	0
2	A	2	0	0	0	0
3	A	1	0	0	0	0
4	A	33	22	0	0	0
5	A	4	0	0	0	0
All	All	4094	4057	4025	28	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 3.

All (28) 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:463:ARG:O	1:A:468:ARG:NH1	2.01	0.94
1:A:386:MET:SD	1:A:474:VAL:CG1	2.96	0.54
1:A:386:MET:SD	1:A:474:VAL:HG13	2.48	0.54
1:A:139:ILE:C	1:A:140:LEU:HD12	2.28	0.54
1:A:468:ARG:HH11	1:A:468:ARG:HG2	1.72	0.54
1:A:439:VAL:HG23	1:A:468:ARG:HD2	1.90	0.53
1:A:308:ILE:O	1:A:310:LEU:HD13	2.10	0.52
1:A:531:TYR:CE1	1:A:535:MET:HE2	2.47	0.50
1:A:30:THR:HG22	1:A:32:LEU:CD1	2.42	0.50
1:A:32:LEU:HD13	1:A:78:VAL:HG13	1.94	0.49
1:A:175:GLY:HA2	1:A:218:LEU:O	2.13	0.49
1:A:295:ASP:HB3	1:A:301:ILE:HD11	1.95	0.48
1:A:385:SER:OG	1:A:475:LEU:HD23	2.13	0.48
1:A:526:ASN:O	1:A:530:THR:OG1	2.31	0.48
1:A:128:ILE:HA	1:A:132:LEU:HD22	1.95	0.47
1:A:161:TYR:HB3	1:A:174:VAL:HG12	1.97	0.47
1:A:531:TYR:CE1	1:A:535:MET:CE	2.99	0.45
1:A:292:ILE:HG23	1:A:300:VAL:HG23	1.98	0.44
1:A:386:MET:SD	1:A:474:VAL:HG11	2.57	0.44
1:A:40:ARG:NH1	1:A:48:SER:HB3	2.33	0.43
1:A:32:LEU:N	1:A:32:LEU:HD12	2.34	0.43
1:A:339:LEU:CD1	1:A:339:LEU:N	2.83	0.42
1:A:32:LEU:CD1	1:A:32:LEU:N	2.83	0.42
1:A:415:LEU:O	1:A:525:ILE:HD11	2.19	0.41
1:A:342:THR:HB	1:A:406:ILE:HD11	2.01	0.41
1:A:138:PRO:HB2	1:A:140:LEU:HD11	2.03	0.41
1:A:124:VAL:HG21	1:A:191:LEU:HD21	2.03	0.41
1:A:440:HIS:CE1	1:A:441:ARG:HG2	2.55	0.41

There are no symmetry-related clashes.

## 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	518/532 (97%)	497 (96%)	20 (4%)	1 (0%)	47	68

All (1) Ramachandran outliers are listed below:

Mol	Chain	Res	Type
1	A	376	ALA

### 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	448/459 (98%)	426 (95%)	22 (5%)	25	47

All (22) residues with a non-rotameric sidechain are listed below:

Mol	Chain	Res	Type
1	A	40	ARG
1	A	53	ASP
1	A	125	GLU
1	A	128	ILE
1	A	132	LEU
1	A	140	LEU
1	A	147	LYS
1	A	163	VAL
1	A	170	VAL
1	A	174	VAL
1	A	208	LYS
1	A	209	THR
1	A	310	LEU
1	A	339	LEU
1	A	341	LYS
1	A	372	ASN
1	A	375	HIS
1	A	385	SER

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Mol	Chain	Res	Type
1	A	423	LEU
1	A	491	GLU
1	A	497	LEU
1	A	530	THR

Some sidechains can be flipped to improve hydrogen bonding and reduce clashes. All (1) such sidechains are listed below:

Mol	Chain	Res	Type
1	A	43	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 carbohydrates in this entry.

## 5.6 Ligand geometry [i](#)

Of 4 ligands modelled in this entry, 3 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	$\# Z  > 2$
4	O05	A	604	2	31,36,36	0.78	2 (6%)	36,55,55	1.41	6 (16%)

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
4	O05	A	604	2	-	7/16/44/44	0/4/4/4

All (2) bond length outliers are listed below:

Mol	Chain	Res	Type	Atoms	Z	Observed(Å)	Ideal(Å)
4	A	604	O05	PB-O1B	2.16	1.54	1.50
4	A	604	O05	PB-O3B	-2.14	1.50	1.54

All (6) bond angle outliers are listed below:

Mol	Chain	Res	Type	Atoms	Z	Observed(°)	Ideal(°)
4	A	604	O05	O2A-PA-C3	4.65	121.36	109.07
4	A	604	O05	C5-C6-N1	-3.85	118.48	121.01
4	A	604	O05	O2B-PB-O1B	-2.50	105.78	112.39
4	A	604	O05	C5-C6-N6	2.33	123.89	120.35
4	A	604	O05	C2-N3-C4	-2.31	112.65	115.28
4	A	604	O05	O2B-PB-O3B	2.19	114.47	108.08

There are no chirality outliers.

All (7) torsion outliers are listed below:

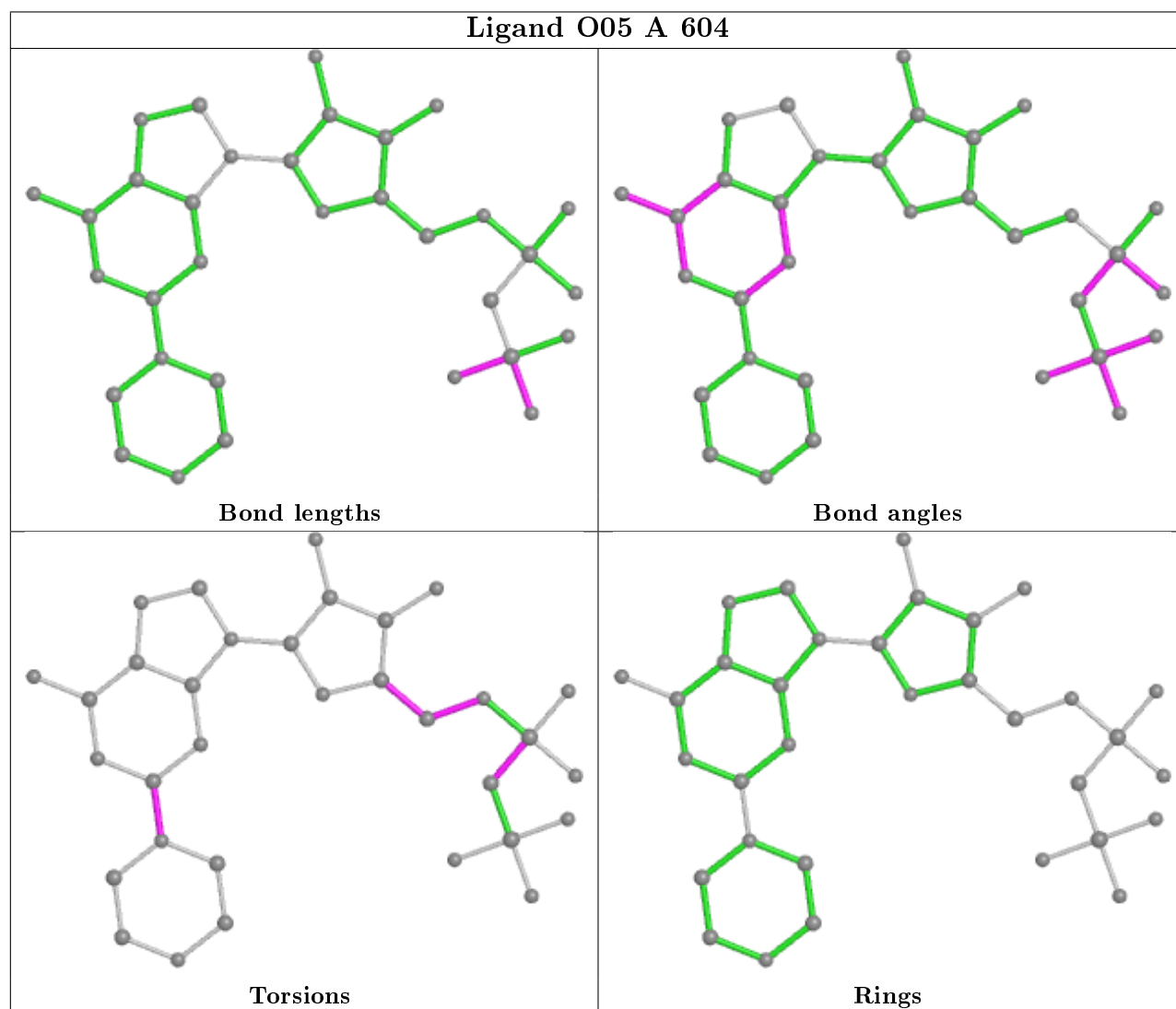
Mol	Chain	Res	Type	Atoms
4	A	604	O05	PB-C3-PA-O2A
4	A	604	O05	PB-C3-PA-O1A
4	A	604	O05	PB-C3-PA-O5'
4	A	604	O05	O4'-C4'-C5'-O5'
4	A	604	O05	C3'-C4'-C5'-O5'
4	A	604	O05	N3-C2-N2-C9
4	A	604	O05	C4'-C5'-O5'-PA

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 ⓘ

### 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, 95<sup>th</sup> 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 <sup>2</sup> )	Q<0.9
1	A	521/532 (97%)	0.62	44 (8%) 11 11	62, 101, 159, 186	0

All (44) RSRZ outliers are listed below:

Mol	Chain	Res	Type	RSRZ
1	A	516	LEU	8.8
1	A	373	LEU	6.0
1	A	150	LEU	5.7
1	A	200	LEU	4.6
1	A	426	LEU	4.0
1	A	495	VAL	4.0
1	A	478	LYS	3.8
1	A	383	HIS	3.7
1	A	408	TRP	3.6
1	A	128	ILE	3.6
1	A	425	GLN	3.5
1	A	188	GLY	3.5
1	A	508	PHE	3.4
1	A	427	LYS	3.3
1	A	423	LEU	3.2
1	A	539	TYR	3.1
1	A	126	GLY	3.1
1	A	189	THR	3.1
1	A	444	GLN	2.8
1	A	492	VAL	2.7
1	A	457	VAL	2.7
1	A	334	TYR	2.7
1	A	384	VAL	2.6
1	A	416	PRO	2.6
1	A	372	ASN	2.6
1	A	154	ILE	2.6
1	A	443	GLY	2.6

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Mol	Chain	Res	Type	RSRZ
1	A	329	ILE	2.5
1	A	120	PHE	2.5
1	A	98	GLY	2.4
1	A	389	LEU	2.4
1	A	431	LEU	2.4
1	A	481	VAL	2.3
1	A	538	ILE	2.2
1	A	537	VAL	2.2
1	A	232	LYS	2.1
1	A	502	ALA	2.1
1	A	424	VAL	2.1
1	A	144	ILE	2.1
1	A	355	PHE	2.1
1	A	171	VAL	2.0
1	A	442	TYR	2.0
1	A	131	LEU	2.0
1	A	501	LEU	2.0

## 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 carbohydrates in this entry.

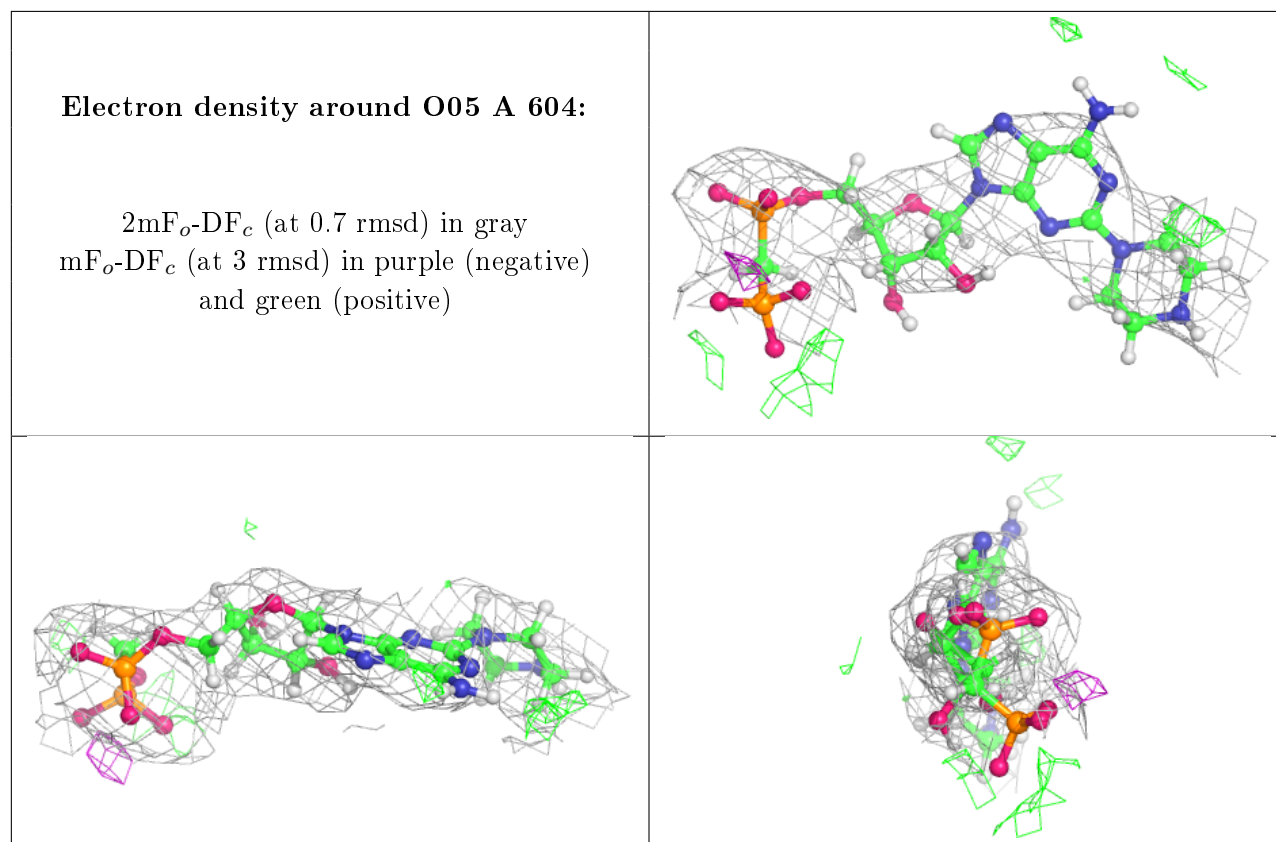
## 6.4 Ligands ⓘ

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, 95<sup>th</sup> 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 <sup>2</sup> )	Q<0.9
3	CA	A	603	1/1	0.68	0.12	80,80,80,80	1
4	O05	A	604	33/33	0.94	0.18	79,123,142,143	0
2	ZN	A	601	1/1	0.94	0.19	80,80,80,80	0
2	ZN	A	602	1/1	0.97	0.20	74,74,74,74	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 [i](#)

There are no such residues in this entry.