



Full wwPDB X-ray Structure Validation Report ⓘ

Apr 25, 2026 – 01:10 AM EDT

PDB ID : 1Q6Z / pdb_00001q6z
Title : HIGH RESOLUTION STRUCTURE OF E28A MUTANT BENZOYL-FORMATE DECARBOXYLASE FROM PSEUDOMONAS PUTIDA COMPLEXED WITH THIAMIN THIAZOLONE DIPHOSPHATE
Authors : Bera, A.K.; Hasson, M.S.
Deposited on : 2003-08-14
Resolution : 1.00 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

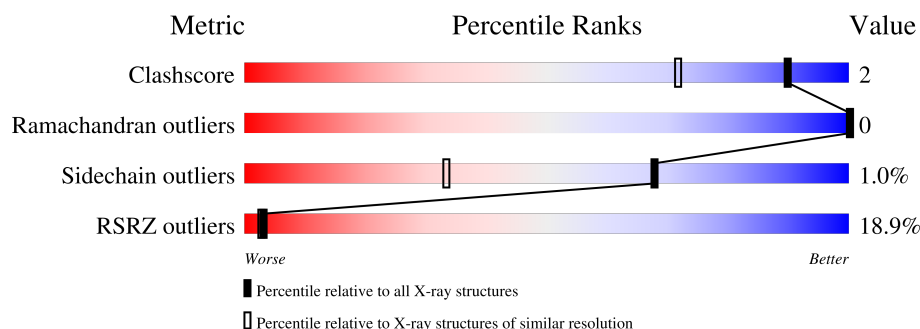
1 Overall quality at a glance

The following experimental techniques were used to determine the structure:

X-RAY DIFFRACTION

The reported resolution of this entry is 1.00 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))
Clashscore	190562	1411 (1.04-0.96)
Ramachandran outliers	187476	1347 (1.04-0.96)
Sidechain outliers	187428	1348 (1.04-0.96)
RSRZ outliers	180081	1355 (1.04-0.96)

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	528	

2 Entry composition

There are 5 unique types of molecules in this entry. The entry contains 4561 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 Benzoylformate decarboxylase.

Mol	Chain	Residues	Atoms					ZeroOcc	AltConf	Trace
1	A	524	Total	C	N	O	S	1	9	0
			3942	2488	682	750	22			

There is a discrepancy between the modelled and reference sequences:

Chain	Residue	Modelled	Actual	Comment	Reference
A	28	ALA	GLU	engineered mutation	UNP P20906

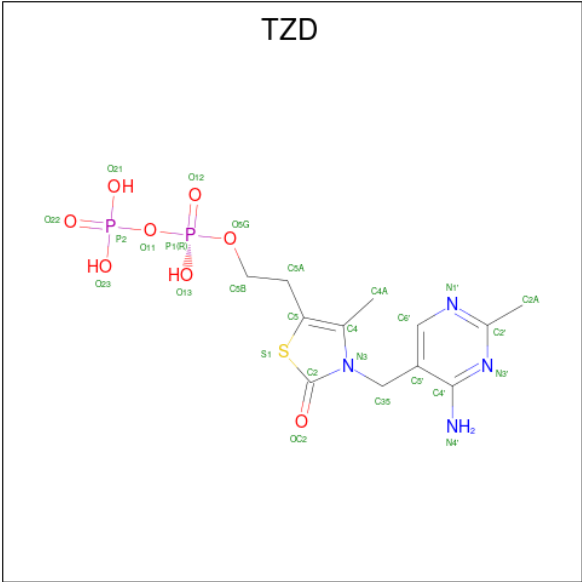
- Molecule 2 is MAGNESIUM ION (CCD ID: MG) (formula: Mg).

Mol	Chain	Residues	Atoms		ZeroOcc	AltConf
2	A	1	Total	Mg	0	0
			1	1		

- Molecule 3 is CALCIUM ION (CCD ID: CA) (formula: Ca).

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

- Molecule 4 is 2-{3-[(4-AMINO-2-METHYLPYRIMIDIN-5-YL)METHYL]-4-METHYL-2-OXO-2,3-DIHYDRO-1,3-THIAZOL-5-YL}ETHYL TRIHYDROGEN DIPHOSPHATE (CCD ID: TZD) (formula: C₁₂H₁₈N₄O₈P₂S).



Mol	Chain	Residues	Atoms						ZeroOcc	AltConf
4	A	1	Total	C	N	O	P	S	0	0
			27	12	4	8	2	1		

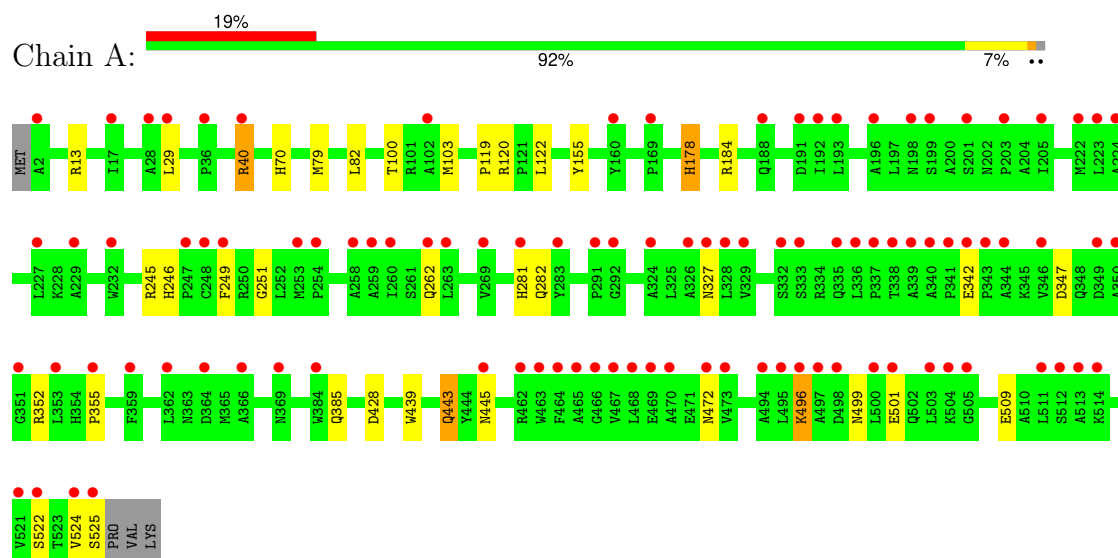
- Molecule 5 is water.

Mol	Chain	Residues	Atoms		ZeroOcc	AltConf
5	A	588	Total	O	0	0
			588	588		

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: Benzoylformate decarboxylase



4 Data and refinement statistics

Property	Value	Source
Space group	I 2 2 2	Depositor
Cell constants a, b, c, α , β , γ	81.37Å 95.60Å 136.88Å 90.00° 90.00° 90.00°	Depositor
Resolution (Å)	30.00 – 1.00 30.00 – 1.00	Depositor EDS
% Data completeness (in resolution range)	85.2 (30.00-1.00) 80.9 (30.00-1.00)	Depositor EDS
R_{merge}	0.05	Depositor
R_{sym}	(Not available)	Depositor
$\langle I/\sigma(I) \rangle$ ¹	1.77 (at 1.00Å)	Xtriage
Refinement program	SHELXL-97, CNS	Depositor
R, R_{free}	0.122 , 0.140 0.159 , (Not available)	Depositor DCC
R_{free} test set	No test flags present.	wwPDB-VP
Wilson B-factor (Å ²)	7.6	Xtriage
Anisotropy	0.185	Xtriage
Bulk solvent k_{sol} (e/Å ³), B_{sol} (Å ²)	0.53 , 92.9	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	0.96	EDS
Total number of atoms	4561	wwPDB-VP
Average B, all atoms (Å ²)	12.0	wwPDB-VP

Xtriage's analysis on translational NCS is as follows: *The largest off-origin peak in the Patterson function is 5.45% 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: TZD, CA, 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	0.98	3/4085 (0.1%)	1.23	24/5581 (0.4%)

All (3) bond length outliers are listed below:

Mol	Chain	Res	Type	Atoms	Z	Observed(Å)	Ideal(Å)
1	A	70	HIS	CE1-NE2	8.66	1.41	1.32
1	A	120	ARG	NE-CZ	-7.02	1.25	1.33
1	A	246	HIS	CG-ND1	-5.23	1.32	1.38

All (24) bond angle outliers are listed below:

Mol	Chain	Res	Type	Atoms	Z	Observed(°)	Ideal(°)
1	A	40	ARG	CD-NE-CZ	18.01	149.61	124.40
1	A	120	ARG	NE-CZ-NH2	13.62	131.46	119.20
1	A	120	ARG	NH1-CZ-NH2	-9.91	106.42	119.30
1	A	443	GLN	OE1-CD-NE2	-9.82	112.78	122.60
1	A	13	ARG	CA-CB-CG	9.09	132.27	114.10
1	A	184	ARG	NE-CZ-NH2	9.04	127.33	119.20
1	A	347	ASP	CA-CB-CG	8.65	121.25	112.60
1	A	281	HIS	CA-CB-CG	8.15	121.95	113.80
1	A	443	GLN	CA-CB-CG	-7.87	98.36	114.10
1	A	327	ASN	OD1-CG-ND2	-7.59	115.01	122.60
1	A	327	ASN	CA-CB-CG	-6.81	105.79	112.60
1	A	443	GLN	CG-CD-NE2	6.79	126.59	116.40
1	A	385	GLN	OE1-CD-NE2	6.72	129.32	122.60
1	A	245	ARG	NE-CZ-NH2	-6.37	113.47	119.20
1	A	472	ASN	OD1-CG-ND2	6.00	128.60	122.60
1	A	282	GLN	OE1-CD-NE2	5.96	128.56	122.60
1	A	428	ASP	CA-CB-CG	5.96	118.56	112.60
1	A	262	GLN	OE1-CD-NE2	5.72	128.32	122.60

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Mol	Chain	Res	Type	Atoms	Z	Observed(°)	Ideal(°)
1	A	178	HIS	CB-CG-CD2	-5.39	124.19	131.20
1	A	472	ASN	CA-CB-CG	-5.36	107.24	112.60
1	A	499	ASN	OD1-CG-ND2	-5.31	117.29	122.60
1	A	445	ASN	OD1-CG-ND2	5.29	127.89	122.60
1	A	184	ARG	NE-CZ-NH1	-5.15	116.35	121.50
1	A	501	GLU	CA-CB-CG	5.09	124.28	114.10

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	3942	0	3871	14	0
2	A	1	0	0	0	0
3	A	3	0	0	0	0
4	A	27	0	15	0	0
5	A	588	0	0	3	0
All	All	4561	0	3886	14	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 (14) 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:79[A]:MET:HE3	1:A:122:LEU:HD12	1.65	0.77
1:A:40:ARG:HD3	5:A:826:HOH:O	1.96	0.64
1:A:496:LYS:HG2	5:A:827:HOH:O	1.97	0.63
1:A:439:TRP:CZ2	1:A:443:GLN:HG3	2.35	0.62
1:A:79[A]:MET:CE	1:A:122:LEU:HD12	2.30	0.61
1:A:439:TRP:CE2	1:A:443:GLN:HG3	2.41	0.55
1:A:178:HIS:HD2	5:A:770:HOH:O	1.90	0.54
1:A:100:THR:CG2	1:A:103[A]:MET:HG3	2.46	0.45
1:A:119:PRO:HG3	1:A:155:TYR:CG	2.53	0.43

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Atom-1	Atom-2	Interatomic distance (Å)	Clash overlap (Å)
1:A:509:GLU:HA	1:A:509:GLU:OE1	2.19	0.42
1:A:355:PRO:HD3	1:A:524:VAL:HG22	2.02	0.42
1:A:79[A]:MET:SD	1:A:82:LEU:HD12	2.61	0.40
1:A:249:PHE:CE2	1:A:251:GLY:HA2	2.56	0.40
1:A:352:ARG:HG2	1:A:522[A]:SER:OG	2.22	0.40

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	531/528 (101%)	522 (98%)	9 (2%)	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	A	418/413 (101%)	414 (99%)	4 (1%)	68	33

All (4) residues with a non-rotameric sidechain are listed below:

Mol	Chain	Res	Type
1	A	29	LEU

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Mol	Chain	Res	Type
1	A	342	GLU
1	A	496	LYS
1	A	525	SER

Sometimes sidechains can be flipped to improve hydrogen bonding and reduce clashes. All (4) such sidechains are listed below:

Mol	Chain	Res	Type
1	A	59	GLN
1	A	151	GLN
1	A	178	HIS
1	A	388	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](#)

Of 5 ligands modelled in this entry, 4 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	TZD	A	530	3	27,28,28	1.55	4 (14%)	37,42,42	1.23	4 (10%)

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	TZD	A	530	3	-	0/17/17/17	0/2/2/2

All (4) bond length outliers are listed below:

Mol	Chain	Res	Type	Atoms	Z	Observed(Å)	Ideal(Å)
4	A	530	TZD	C2-S1	-6.00	1.70	1.77
4	A	530	TZD	OC2-C2	2.39	1.25	1.21
4	A	530	TZD	C5'-C4'	2.29	1.46	1.42
4	A	530	TZD	C2-N3	2.21	1.41	1.38

All (4) bond angle outliers are listed below:

Mol	Chain	Res	Type	Atoms	Z	Observed(°)	Ideal(°)
4	A	530	TZD	OC2-C2-N3	-3.20	121.62	125.37
4	A	530	TZD	C2A-C2'-N3'	2.35	120.64	117.13
4	A	530	TZD	C6'-N1'-C2'	2.11	119.53	116.07
4	A	530	TZD	N1'-C2'-N3'	-2.07	122.08	125.53

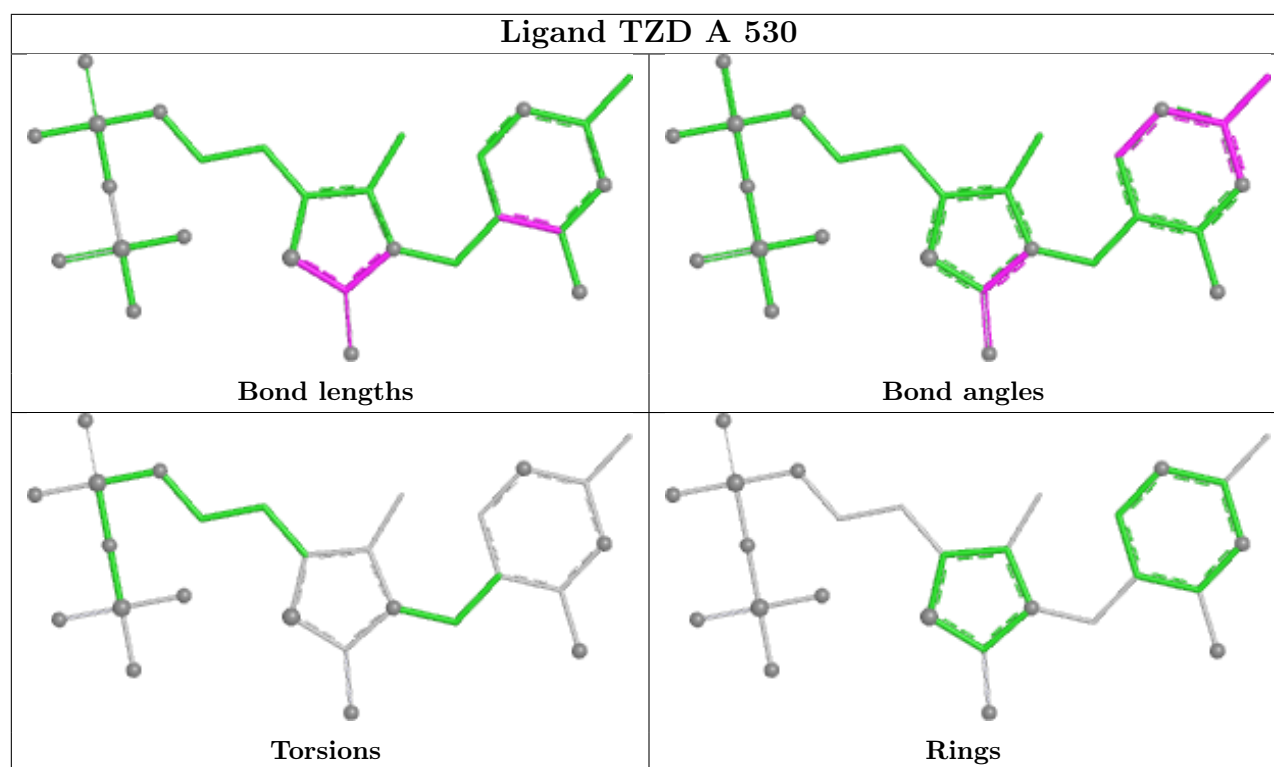
There are no chirality outliers.

There are no torsion outliers.

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, 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	524/528 (99%)	1.10	99 (18%) 3 3	6, 9, 18, 36	30 (5%)

All (99) RSRZ outliers are listed below:

Mol	Chain	Res	Type	RSRZ
1	A	463	TRP	5.9
1	A	343	PRO	5.9
1	A	283	TYR	5.8
1	A	344	ALA	5.7
1	A	341	PRO	5.6
1	A	232	TRP	5.6
1	A	350	ALA	5.2
1	A	333	SER	5.2
1	A	524	VAL	5.0
1	A	364	ASP	4.6
1	A	254	PRO	4.3
1	A	514	LYS	4.2
1	A	511	LEU	4.2
1	A	169	PRO	4.2
1	A	467	VAL	4.2
1	A	342	GLU	4.0
1	A	497	ALA	4.0
1	A	525	SER	3.9
1	A	469	GLU	3.9
1	A	359	PHE	3.8
1	A	468	LEU	3.8
1	A	339	ALA	3.7
1	A	291	PRO	3.7
1	A	249	PHE	3.5
1	A	464	PHE	3.5
1	A	338	THR	3.5
1	A	513	ALA	3.4

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Mol	Chain	Res	Type	RSRZ
1	A	263	LEU	3.4
1	A	29	LEU	3.4
1	A	336	LEU	3.3
1	A	258	ALA	3.3
1	A	335	GLN	3.3
1	A	470	ALA	3.3
1	A	201	SER	3.2
1	A	227	LEU	3.1
1	A	192	ILE	3.1
1	A	2	ALA	3.1
1	A	445	ASN	3.1
1	A	466	GLY	3.0
1	A	337	PRO	2.9
1	A	223	LEU	2.9
1	A	262	GLN	2.9
1	A	326	ALA	2.9
1	A	247	PRO	2.8
1	A	512	SER	2.8
1	A	259	ALA	2.8
1	A	500	LEU	2.8
1	A	40	ARG	2.7
1	A	501	GLU	2.7
1	A	36	PRO	2.7
1	A	465	ALA	2.7
1	A	496	LYS	2.7
1	A	327	ASN	2.6
1	A	351	GLY	2.6
1	A	355	PRO	2.6
1	A	462	ARG	2.6
1	A	340	ALA	2.6
1	A	503	LEU	2.6
1	A	329	VAL	2.6
1	A	260	ILE	2.6
1	A	494	ALA	2.5
1	A	203	PRO	2.5
1	A	498	ASP	2.5
1	A	292	GLY	2.4
1	A	196	ALA	2.4
1	A	472	ASN	2.4
1	A	362	LEU	2.4
1	A	281	HIS	2.4
1	A	346	VAL	2.4

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Mol	Chain	Res	Type	RSRZ
1	A	191	ASP	2.3
1	A	17	ILE	2.3
1	A	505	GLY	2.3
1	A	353	LEU	2.3
1	A	522[A]	SER	2.3
1	A	324	ALA	2.3
1	A	248	CYS	2.2
1	A	224	ALA	2.2
1	A	269	VAL	2.2
1	A	193	LEU	2.2
1	A	188	GLN	2.2
1	A	349	ASP	2.2
1	A	495	LEU	2.2
1	A	199	SER	2.1
1	A	384	TRP	2.1
1	A	504	LYS	2.1
1	A	222[A]	MET	2.1
1	A	198	ASN	2.1
1	A	205	ILE	2.1
1	A	328	LEU	2.1
1	A	473	VAL	2.1
1	A	521	VAL	2.1
1	A	28	ALA	2.1
1	A	229	ALA	2.1
1	A	366	ALA	2.1
1	A	253	MET	2.0
1	A	160	TYR	2.0
1	A	369	ASN	2.0
1	A	102	ALA	2.0
1	A	332	SER	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 ⓘ

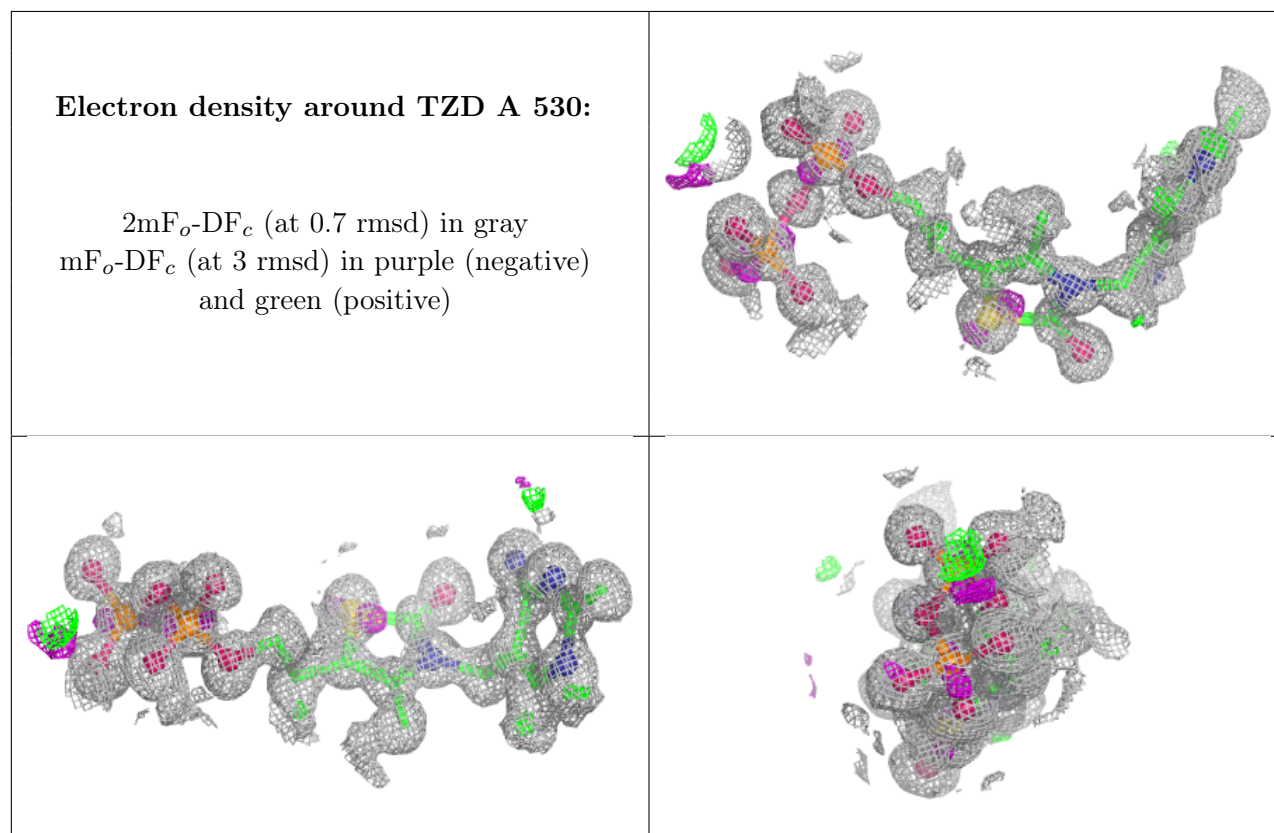
There are no oligosaccharides in this entry.

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
3	CA	A	533	1/1	0.93	0.13	12,12,12,12	1
2	MG	A	531	1/1	0.99	0.09	8,8,8,8	1
3	CA	A	534	1/1	0.99	0.04	8,8,8,8	1
4	TZD	A	530	27/27	0.99	0.04	6,7,8,8	0
3	CA	A	532	1/1	1.00	0.03	7,7,7,7	1

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.