



wwPDB X-ray Structure Validation Summary Report ⓘ

Mar 6, 2026 – 04:18 PM UTC

PDB ID : 5XO6 / pdb_00005xo6
Title : Crystal structure of a novel ZEN lactonase mutant
Authors : Zheng, Y.Y.; Liu, W.T.; Liu, W.D.; Chen, C.C.; Guo, R.T.
Deposited on : 2017-05-27
Resolution : 2.38 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
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

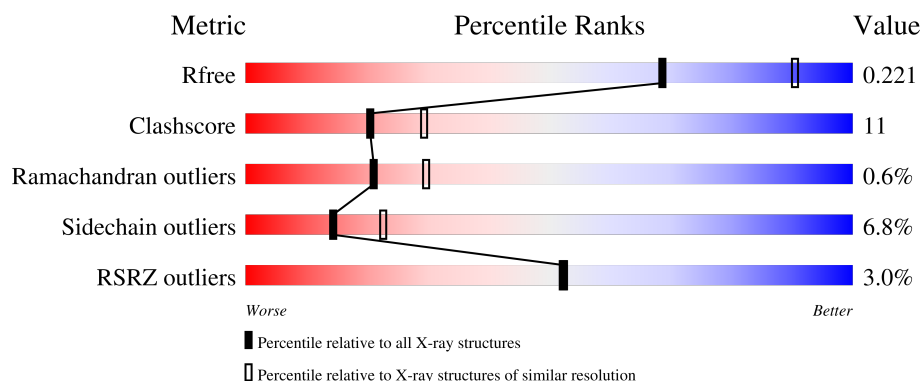
1 Overall quality at a glance ⓘ

The following experimental techniques were used to determine the structure:

X-RAY DIFFRACTION

The reported resolution of this entry is 2.38 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	7164 (2.40-2.36)
Clashscore	190562	7722 (2.40-2.36)
Ramachandran outliers	187476	7626 (2.40-2.36)
Sidechain outliers	187428	7627 (2.40-2.36)
RSRZ outliers	180081	7170 (2.40-2.36)

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	A	266	79% 18% ..
1	B	266	79% 18% ..
1	C	266	3% 75% 20% ..
1	D	266	2% 71% 24% ..
1	E	266	% 70% 20% 8% .

Continued on next page...

Continued from previous page...

Mol	Chain	Length	Quality of chain
1	F	266	5% 68% 25%
1	G	266	9% 64% 28% 5%
1	H	266	3% 64% 31%

2 Entry composition

There are 3 unique types of molecules in this entry. The entry contains 16963 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.

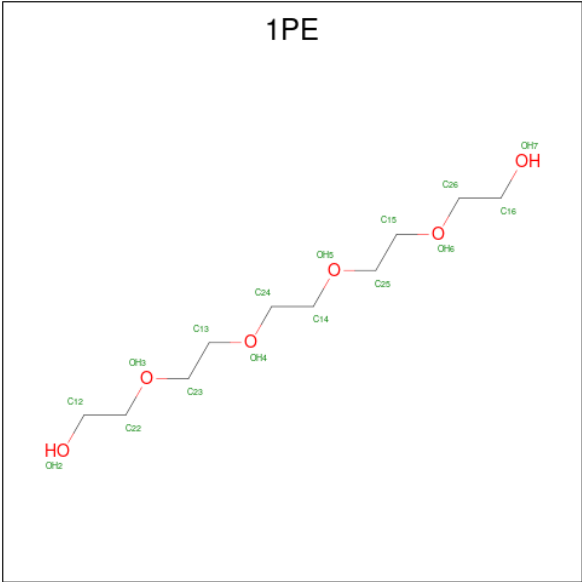
- Molecule 1 is a protein called lactonase for protein.

Mol	Chain	Residues	Atoms					ZeroOcc	AltConf	Trace
1	A	263	Total	C	N	O	S	0	0	0
			2055	1306	347	393	9			
1	B	263	Total	C	N	O	S	0	0	0
			2055	1306	347	393	9			
1	C	263	Total	C	N	O	S	0	0	0
			2055	1306	347	393	9			
1	D	263	Total	C	N	O	S	0	0	0
			2055	1306	347	393	9			
1	E	262	Total	C	N	O	S	0	0	0
			2045	1300	345	391	9			
1	F	259	Total	C	N	O	S	0	0	0
			2021	1282	341	389	9			
1	G	257	Total	C	N	O	S	0	0	0
			2003	1274	337	383	9			
1	H	263	Total	C	N	O	S	0	0	0
			2055	1306	347	393	9			

There are 8 discrepancies between the modelled and reference sequences:

Chain	Residue	Modelled	Actual	Comment	Reference
A	105	ALA	SER	engineered mutation	UNP A0A0D2ILK1
B	105	ALA	SER	engineered mutation	UNP A0A0D2ILK1
C	105	ALA	SER	engineered mutation	UNP A0A0D2ILK1
D	105	ALA	SER	engineered mutation	UNP A0A0D2ILK1
E	105	ALA	SER	engineered mutation	UNP A0A0D2ILK1
F	105	ALA	SER	engineered mutation	UNP A0A0D2ILK1
G	105	ALA	SER	engineered mutation	UNP A0A0D2ILK1
H	105	ALA	SER	engineered mutation	UNP A0A0D2ILK1

- Molecule 2 is PENTAETHYLENE GLYCOL (CCD ID: 1PE) (formula: C₁₀H₂₂O₆).



Mol	Chain	Residues	Atoms			ZeroOcc	AltConf
2	A	1	Total	C	O	0	0
			16	10	6		
2	B	1	Total	C	O	0	0
			16	10	6		

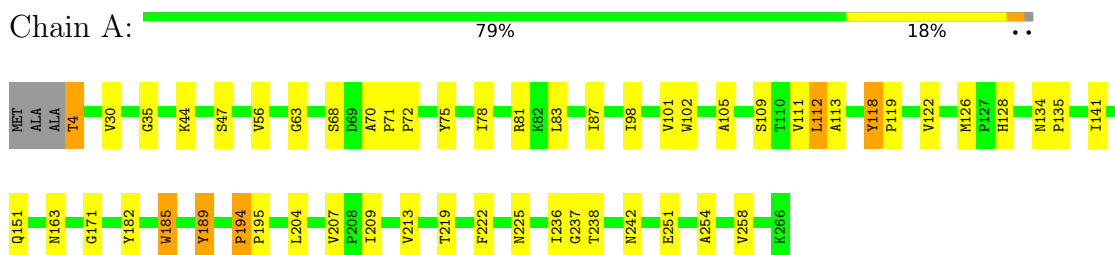
- Molecule 3 is water.

Mol	Chain	Residues	Atoms		ZeroOcc	AltConf
3	A	164	Total	O	0	0
			164	164		
3	B	144	Total	O	0	0
			144	144		
3	C	50	Total	O	0	0
			50	50		
3	D	57	Total	O	0	0
			57	57		
3	E	59	Total	O	0	0
			59	59		
3	F	39	Total	O	0	0
			39	39		
3	G	31	Total	O	0	0
			31	31		
3	H	43	Total	O	0	0
			43	43		

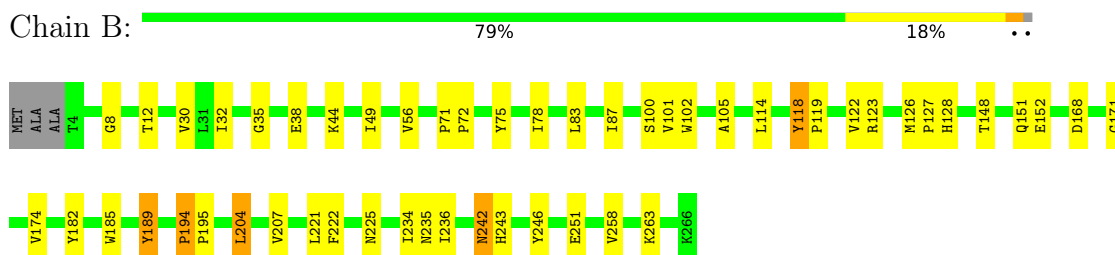
3 Residue-property plots [i](#)

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.

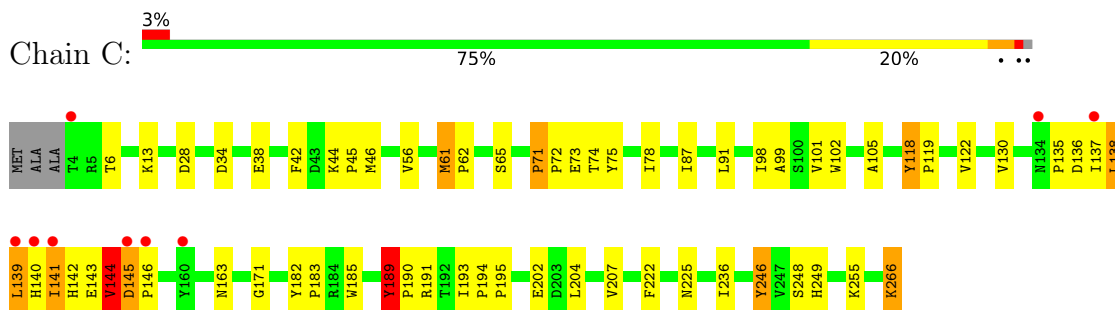
- Molecule 1: lactonase for protein



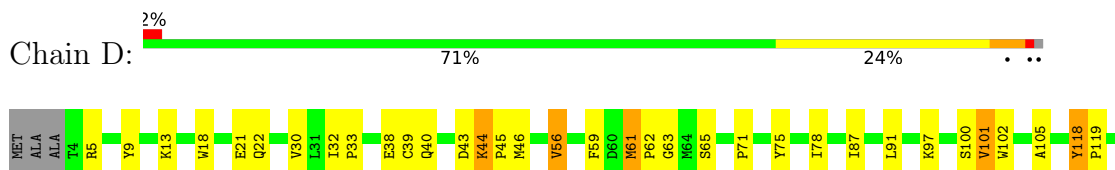
- Molecule 1: lactonase for protein

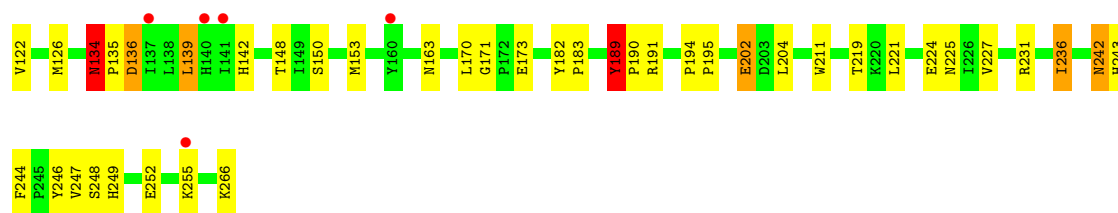


- Molecule 1: lactonase for protein

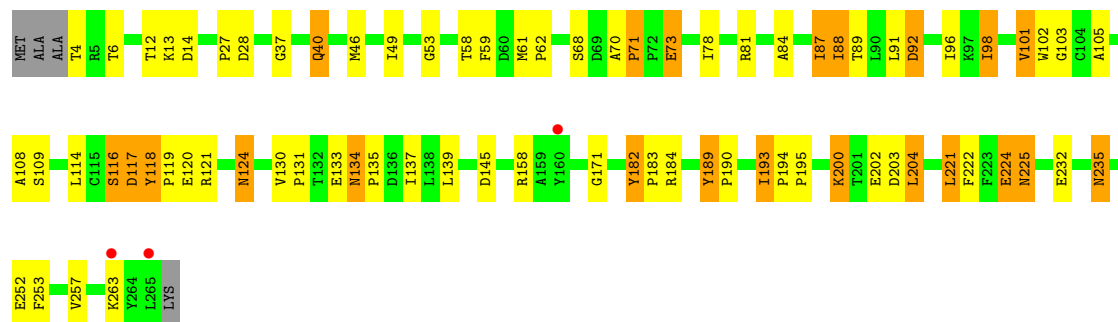


- Molecule 1: lactonase for protein

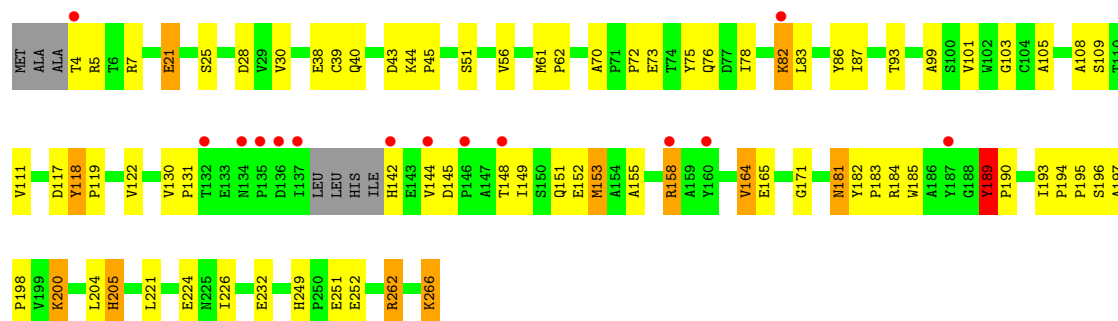




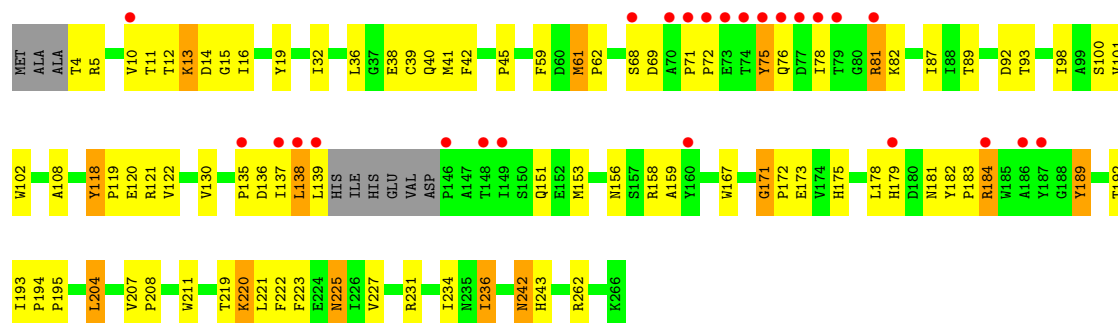
- Molecule 1: lactonase for protein



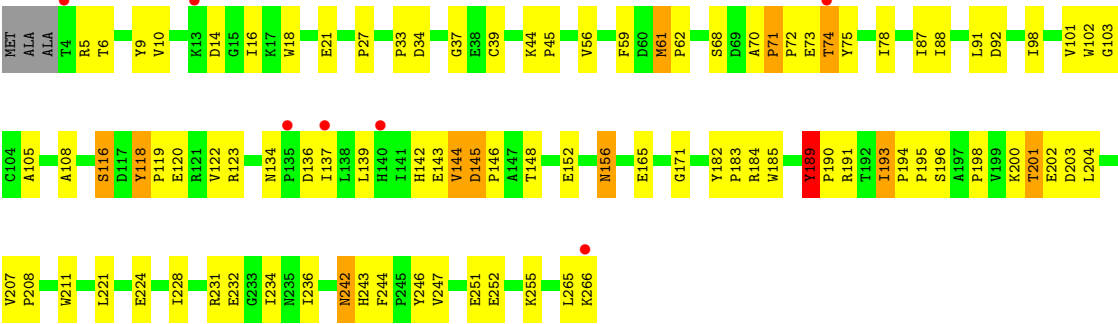
- Molecule 1: lactonase for protein



- Molecule 1: lactonase for protein



- Molecule 1: lactonase for protein



4 Data and refinement statistics

Property	Value	Source
Space group	P 1	Depositor
Cell constants a, b, c, α , β , γ	76.01Å 96.89Å 101.89Å 88.96° 87.70° 87.96°	Depositor
Resolution (Å)	24.81 – 2.38 24.81 – 2.38	Depositor EDS
% Data completeness (in resolution range)	98.0 (24.81-2.38) 98.3 (24.81-2.38)	Depositor EDS
R_{merge}	0.06	Depositor
R_{sym}	(Not available)	Depositor
$\langle I/\sigma(I) \rangle$ ¹	2.84 (at 2.39Å)	Xtriage
Refinement program	REFMAC 5.8.0103	Depositor
R, R_{free}	0.166 , 0.216 0.184 , 0.221	Depositor DCC
R_{free} test set	1955 reflections (1.67%)	wwPDB-VP
Wilson B-factor (Å ²)	42.3	Xtriage
Anisotropy	0.145	Xtriage
Bulk solvent k_{sol} (e/Å ³), B_{sol} (Å ²)	0.33 , 38.2	EDS
L-test for twinning ²	$\langle L \rangle = 0.50$, $\langle L^2 \rangle = 0.33$	Xtriage
Estimated twinning fraction	0.010 for -h,k,-l	Xtriage
F_o, F_c correlation	0.96	EDS
Total number of atoms	16963	wwPDB-VP
Average B, all atoms (Å ²)	53.0	wwPDB-VP

Xtriage's analysis on translational NCS is as follows: *The largest off-origin peak in the Patterson function is 3.73% 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: 1PE

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	1.97	26/2114 (1.2%)	1.11	11/2886 (0.4%)
1	B	1.97	24/2114 (1.1%)	1.11	13/2886 (0.5%)
1	C	1.67	4/2114 (0.2%)	1.15	18/2886 (0.6%)
1	D	1.66	10/2114 (0.5%)	1.12	19/2886 (0.7%)
1	E	1.64	3/2104 (0.1%)	1.17	20/2875 (0.7%)
1	F	1.61	4/2078 (0.2%)	1.22	19/2835 (0.7%)
1	G	1.55	2/2059 (0.1%)	1.16	12/2808 (0.4%)
1	H	1.57	1/2114 (0.0%)	1.17	23/2886 (0.8%)
All	All	1.71	74/16811 (0.4%)	1.15	135/22948 (0.6%)

The worst 5 of 74 bond length outliers are listed below:

Mol	Chain	Res	Type	Atoms	Z	Observed(Å)	Ideal(Å)
1	B	71	PRO	C-O	-8.85	1.17	1.25
1	A	71	PRO	C-O	-7.39	1.18	1.25
1	F	131	PRO	C-N	-7.00	1.23	1.33
1	C	105	ALA	C-O	-6.91	1.18	1.24
1	B	207	VAL	C-O	-6.86	1.18	1.24

The worst 5 of 135 bond angle outliers are listed below:

Mol	Chain	Res	Type	Atoms	Z	Observed(°)	Ideal(°)
1	G	171	GLY	CA-C-N	10.45	130.24	118.85
1	G	171	GLY	C-N-CA	10.45	130.24	118.85
1	F	171	GLY	CA-C-N	10.21	130.96	119.32
1	F	171	GLY	C-N-CA	10.21	130.96	119.32
1	H	71	PRO	CA-C-N	10.04	132.38	119.84

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	2055	0	1993	15	0
1	B	2055	0	1993	13	0
1	C	2055	0	1993	46	0
1	D	2055	0	1993	45	0
1	E	2045	0	1980	43	0
1	F	2021	0	1952	65	0
1	G	2003	0	1949	66	0
1	H	2055	0	1993	67	0
2	A	16	0	22	3	0
2	B	16	0	22	3	0
3	A	164	0	0	1	0
3	B	144	0	0	1	0
3	C	50	0	0	2	0
3	D	57	0	0	2	0
3	E	59	0	0	0	0
3	F	39	0	0	0	0
3	G	31	0	0	1	0
3	H	43	0	0	0	0
All	All	16963	0	15890	360	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 11.

The worst 5 of 360 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:F:82:LYS:HE3	1:F:86:TYR:CE1	1.49	1.45
1:F:82:LYS:HE3	1:F:86:TYR:CZ	1.66	1.27
1:C:145:ASP:OD1	1:C:146:PRO:HD2	1.32	1.25
1:G:75:TYR:HE2	1:G:184:ARG:CD	1.53	1.21
1:H:136:ASP:HA	1:H:139:LEU:CD1	1.78	1.14

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	261/266 (98%)	252 (97%)	7 (3%)	2 (1%)	16	23
1	B	261/266 (98%)	254 (97%)	6 (2%)	1 (0%)	30	40
1	C	261/266 (98%)	245 (94%)	13 (5%)	3 (1%)	11	16
1	D	261/266 (98%)	251 (96%)	8 (3%)	2 (1%)	16	23
1	E	260/266 (98%)	247 (95%)	12 (5%)	1 (0%)	30	40
1	F	255/266 (96%)	241 (94%)	13 (5%)	1 (0%)	30	40
1	G	253/266 (95%)	234 (92%)	17 (7%)	2 (1%)	16	23
1	H	261/266 (98%)	249 (95%)	11 (4%)	1 (0%)	30	40
All	All	2073/2128 (97%)	1973 (95%)	87 (4%)	13 (1%)	21	30

5 of 13 Ramachandran outliers are listed below:

Mol	Chain	Res	Type
1	A	163	ASN
1	B	189	TYR
1	G	69	ASP
1	A	189	TYR
1	C	163	ASN

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	223/224 (100%)	219 (98%)	4 (2%)	51	71

Continued on next page...

Continued from previous page...

Mol	Chain	Analysed	Rotameric	Outliers	Percentiles	
1	B	223/224 (100%)	219 (98%)	4 (2%)	51	71
1	C	223/224 (100%)	209 (94%)	14 (6%)	16	26
1	D	223/224 (100%)	206 (92%)	17 (8%)	12	19
1	E	222/224 (99%)	199 (90%)	23 (10%)	7	9
1	F	219/224 (98%)	198 (90%)	21 (10%)	8	11
1	G	217/224 (97%)	201 (93%)	16 (7%)	13	19
1	H	223/224 (100%)	202 (91%)	21 (9%)	8	12
All	All	1773/1792 (99%)	1653 (93%)	120 (7%)	14	23

5 of 120 residues with a non-rotameric sidechain are listed below:

Mol	Chain	Res	Type
1	E	200	LYS
1	H	193	ILE
1	F	145	ASP
1	H	165	GLU
1	H	255	LYS

Sometimes sidechains can be flipped to improve hydrogen bonding and reduce clashes. 5 of 14 such sidechains are listed below:

Mol	Chain	Res	Type
1	D	140	HIS
1	E	52	ASN
1	H	124	ASN
1	F	181	ASN
1	G	124	ASN

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 [i](#)

There are no oligosaccharides in this entry.

5.6 Ligand geometry [i](#)

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	1PE	B	301	-	15,15,15	0.94	0	14,14,14	1.41	1 (7%)
2	1PE	A	301	-	15,15,15	0.98	0	14,14,14	1.67	3 (21%)

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	1PE	B	301	-	-	10/13/13/13	-
2	1PE	A	301	-	-	8/13/13/13	-

There are no bond length outliers.

All (4) bond angle outliers are listed below:

Mol	Chain	Res	Type	Atoms	Z	Observed(°)	Ideal(°)
2	A	301	1PE	C25-OH5-C14	4.46	132.78	113.26
2	B	301	1PE	C26-OH6-C15	4.01	130.79	113.26
2	A	301	1PE	OH5-C14-C24	2.81	123.17	110.35
2	A	301	1PE	OH4-C13-C23	2.02	119.54	110.35

There are no chirality outliers.

5 of 18 torsion outliers are listed below:

Mol	Chain	Res	Type	Atoms
2	B	301	1PE	OH4-C13-C23-OH3
2	A	301	1PE	OH7-C16-C26-OH6
2	B	301	1PE	C24-C14-OH5-C25
2	A	301	1PE	OH2-C12-C22-OH3
2	B	301	1PE	OH6-C15-C25-OH5

There are no ring outliers.

2 monomers are involved in 6 short contacts:

Mol	Chain	Res	Type	Clashes	Symm-Clashes
2	B	301	1PE	3	0
2	A	301	1PE	3	0

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	263/266 (98%)	-0.44	0	100	100	23, 34, 53, 70	0
1	B	263/266 (98%)	-0.40	0	100	100	23, 34, 56, 75	0
1	C	263/266 (98%)	0.08	9 (3%)	48	48	31, 52, 94, 141	0
1	D	263/266 (98%)	0.03	5 (1%)	66	65	32, 52, 94, 124	0
1	E	262/266 (98%)	0.10	3 (1%)	78	77	32, 57, 82, 104	0
1	F	259/266 (97%)	0.37	14 (5%)	31	31	33, 55, 93, 131	0
1	G	257/266 (96%)	0.48	25 (9%)	13	12	27, 56, 106, 140	0
1	H	263/266 (98%)	0.26	7 (2%)	56	56	30, 58, 89, 131	0
All	All	2093/2128 (98%)	0.06	63 (3%)	52	52	23, 50, 87, 141	0

The worst 5 of 63 RSRZ outliers are listed below:

Mol	Chain	Res	Type	RSRZ
1	F	134	ASN	5.5
1	G	75	TYR	4.7
1	G	137	ILE	4.6
1	G	78	ILE	4.6
1	F	142	HIS	4.5

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	1PE	B	301	16/16	0.84	0.22	44,65,91,95	0
2	1PE	A	301	16/16	0.88	0.17	40,65,78,81	0

6.5 Other polymers [i](#)

There are no such residues in this entry.