



wwPDB X-ray Structure Validation Summary Report ⓘ

Mar 10, 2026 – 10:08 AM UTC

PDB ID : 6XC0 / pdb_00006xc0
Title : Crystal structure of bacteriophage T4 spackle and lysozyme in monoclinic form
Authors : Shi, K.; Oakland, J.T.; Kurniawan, F.; Moeller, N.H.; Aihara, H.
Deposited on : 2020-06-07
Resolution : 1.78 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

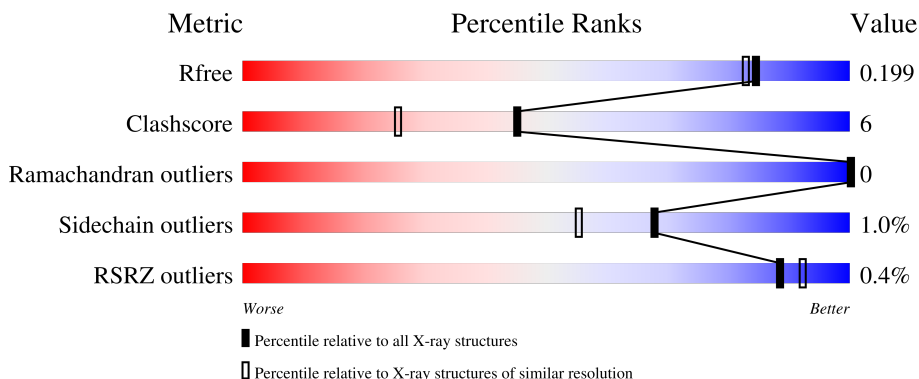
1 Overall quality at a glance

The following experimental techniques were used to determine the structure:

X-RAY DIFFRACTION

The reported resolution of this entry is 1.78 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	1365 (1.78-1.78)
Clashscore	190562	1395 (1.78-1.78)
Ramachandran outliers	187476	1382 (1.78-1.78)
Sidechain outliers	187428	1382 (1.78-1.78)
RSRZ outliers	180081	1365 (1.78-1.78)

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	177	% 84% 10% • 6%
1	B	177	 86% 7% • 6%
2	C	105	% 63% 9% • 28%
2	D	105	 62% 10% 29%

2 Entry composition

There are 8 unique types of molecules in this entry. The entry contains 4479 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 Lysozyme.

Mol	Chain	Residues	Atoms					ZeroOcc	AltConf	Trace
1	A	167	Total	C	N	O	S	0	2	0
			1325	828	238	246	13			
1	B	167	Total	C	N	O	S	0	3	0
			1333	832	240	248	13			

There are 16 discrepancies between the modelled and reference sequences:

Chain	Residue	Modelled	Actual	Comment	Reference
A	343	LEU	-	expression tag	UNP P16009
A	344	GLU	-	expression tag	UNP P16009
A	345	HIS	-	expression tag	UNP P16009
A	346	HIS	-	expression tag	UNP P16009
A	347	HIS	-	expression tag	UNP P16009
A	348	HIS	-	expression tag	UNP P16009
A	349	HIS	-	expression tag	UNP P16009
A	350	HIS	-	expression tag	UNP P16009
B	343	LEU	-	expression tag	UNP P16009
B	344	GLU	-	expression tag	UNP P16009
B	345	HIS	-	expression tag	UNP P16009
B	346	HIS	-	expression tag	UNP P16009
B	347	HIS	-	expression tag	UNP P16009
B	348	HIS	-	expression tag	UNP P16009
B	349	HIS	-	expression tag	UNP P16009
B	350	HIS	-	expression tag	UNP P16009

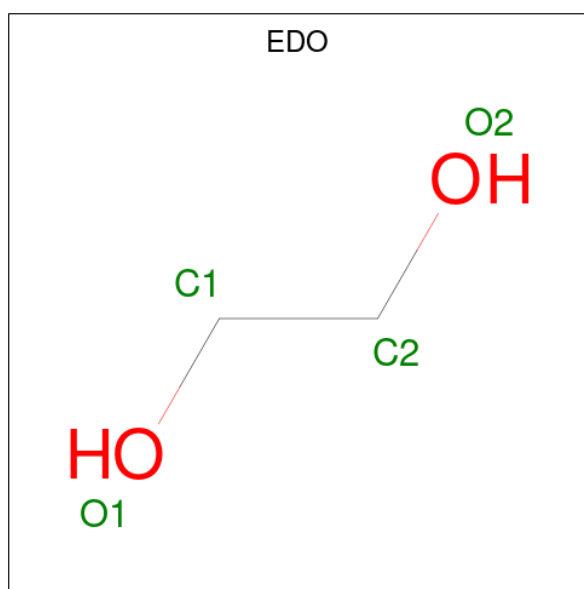
- Molecule 2 is a protein called Protein spackle.

Mol	Chain	Residues	Atoms					ZeroOcc	AltConf	Trace
2	C	76	Total	C	N	O	S	1	2	0
			624	387	103	126	8			
2	D	75	Total	C	N	O	S	1	3	0
			625	386	104	127	8			

There are 16 discrepancies between the modelled and reference sequences:

Chain	Residue	Modelled	Actual	Comment	Reference
C	98	LEU	-	expression tag	UNP P39230
C	99	GLU	-	expression tag	UNP P39230
C	100	HIS	-	expression tag	UNP P39230
C	101	HIS	-	expression tag	UNP P39230
C	102	HIS	-	expression tag	UNP P39230
C	103	HIS	-	expression tag	UNP P39230
C	104	HIS	-	expression tag	UNP P39230
C	105	HIS	-	expression tag	UNP P39230
D	98	LEU	-	expression tag	UNP P39230
D	99	GLU	-	expression tag	UNP P39230
D	100	HIS	-	expression tag	UNP P39230
D	101	HIS	-	expression tag	UNP P39230
D	102	HIS	-	expression tag	UNP P39230
D	103	HIS	-	expression tag	UNP P39230
D	104	HIS	-	expression tag	UNP P39230
D	105	HIS	-	expression tag	UNP P39230

- Molecule 3 is 1,2-ETHANEDIOL (CCD ID: EDO) (formula: C₂H₆O₂).



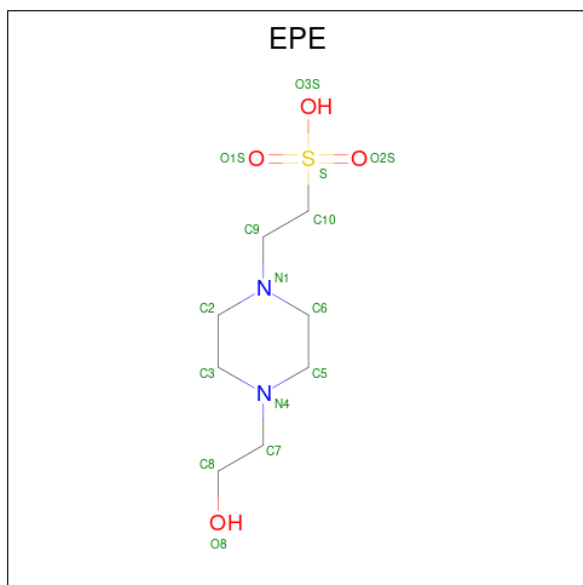
Mol	Chain	Residues	Atoms	ZeroOcc	AltConf
3	A	1	Total C O 4 2 2	0	0
3	C	1	Total C O 4 2 2	0	0
3	D	1	Total C O 4 2 2	0	0

Continued on next page...

Continued from previous page...

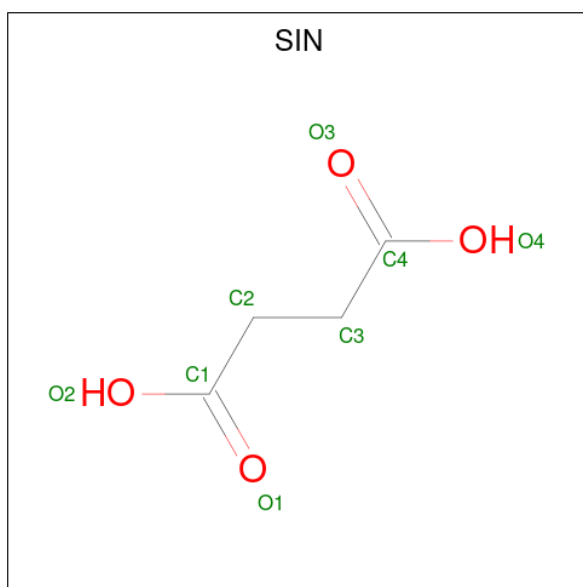
Mol	Chain	Residues	Atoms			ZeroOcc	AltConf
3	D	1	Total	C	O	0	0
			4	2	2		

- Molecule 4 is 4-(2-HYDROXYETHYL)-1-PIPERAZINE ETHANESULFONIC ACID (CCD ID: EPE) (formula: C₈H₁₈N₂O₄S).



Mol	Chain	Residues	Atoms					ZeroOcc	AltConf
4	A	1	Total	C	N	O	S	0	0
			15	8	2	4	1		
4	B	1	Total	C	N	O	S	0	0
			15	8	2	4	1		
4	B	1	Total	C	N	O	S	0	0
			15	8	2	4	1		

- Molecule 5 is SUCCINIC ACID (CCD ID: SIN) (formula: C₄H₆O₄).



Mol	Chain	Residues	Atoms			ZeroOcc	AltConf
5	A	1	Total	C	O	0	0
			8	4	4		

- Molecule 6 is CHLORIDE ION (CCD ID: CL) (formula: Cl).

Mol	Chain	Residues	Atoms		ZeroOcc	AltConf
6	B	1	Total	Cl	0	0
			1	1		
6	C	1	Total	Cl	0	0
			1	1		
6	D	1	Total	Cl	0	0
			1	1		

- Molecule 7 is FORMIC ACID (CCD ID: FMT) (formula: CH₂O₂).



Mol	Chain	Residues	Atoms			ZeroOcc	AltConf
7	C	1	Total	C	O	0	0
			3	1	2		

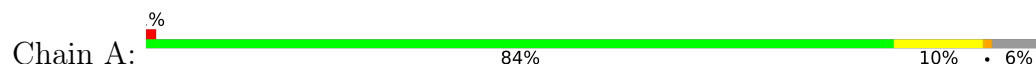
- Molecule 8 is water.

Mol	Chain	Residues	Atoms		ZeroOcc	AltConf
8	A	170	Total	O	0	0
			170	170		
8	B	157	Total	O	0	0
			157	157		
8	C	86	Total	O	0	0
			86	86		
8	D	84	Total	O	0	0
			84	84		

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: Lysozyme



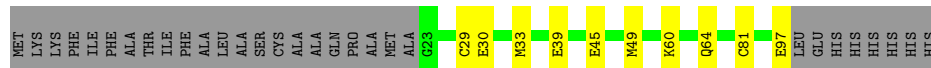
- Molecule 1: Lysozyme



- Molecule 2: Protein spackle



- Molecule 2: Protein spackle



4 Data and refinement statistics

Property	Value	Source
Space group	P 1 21 1	Depositor
Cell constants a, b, c, α , β , γ	41.31Å 127.60Å 46.09Å 90.00° 92.25° 90.00°	Depositor
Resolution (Å)	63.80 – 1.78 63.80 – 1.78	Depositor EDS
% Data completeness (in resolution range)	98.3 (63.80-1.78) 98.3 (63.80-1.78)	Depositor EDS
R_{merge}	0.11	Depositor
R_{sym}	(Not available)	Depositor
$\langle I/\sigma(I) \rangle$ ¹	1.77 (at 1.78Å)	Xtriage
Refinement program	PHENIX 1.18_3861	Depositor
R, R_{free}	0.156 , 0.198 0.161 , 0.199	Depositor DCC
R_{free} test set	2286 reflections (5.11%)	wwPDB-VP
Wilson B-factor (Å ²)	26.0	Xtriage
Anisotropy	0.251	Xtriage
Bulk solvent k_{sol} (e/Å ³), B_{sol} (Å ²)	0.35 , 47.3	EDS
L-test for twinning ²	$\langle L \rangle = 0.49$, $\langle L^2 \rangle = 0.32$	Xtriage
Estimated twinning fraction	0.118 for h,-k,-l	Xtriage
F_o, F_c correlation	0.96	EDS
Total number of atoms	4479	wwPDB-VP
Average B, all atoms (Å ²)	29.0	wwPDB-VP

Xtriage's analysis on translational NCS is as follows: *The largest off-origin peak in the Patterson function is 7.96% 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: EPE, FMT, SIN, EDO, CL

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	0.58	0/1346	0.68	0/1808
1	B	0.59	0/1354	0.67	0/1819
2	C	0.55	0/631	0.67	0/848
2	D	0.56	0/632	0.68	0/849
All	All	0.58	0/3963	0.68	0/5324

There are no bond length outliers.

There are no bond angle outliers.

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	1325	0	1335	20	1
1	B	1333	0	1340	11	1
2	C	624	0	603	9	0
2	D	625	0	599	8	0
3	A	4	0	6	1	0
3	C	4	0	6	0	0
3	D	8	0	12	1	0
4	A	15	0	18	0	0
4	B	30	0	36	3	0

Continued on next page...

Continued from previous page...

Mol	Chain	Non-H	H(model)	H(added)	Clashes	Symm-Clashes
5	A	8	0	4	0	0
6	B	1	0	0	0	0
6	C	1	0	0	0	0
6	D	1	0	0	0	0
7	C	3	0	1	0	0
8	A	170	0	0	5	0
8	B	157	0	0	5	0
8	C	86	0	0	2	0
8	D	84	0	0	2	0
All	All	4479	0	3960	47	1

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 6.

The worst 5 of 47 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:214:MET:HE2	1:A:234:GLY:H	0.95	1.07
1:A:214:MET:HE2	1:A:234:GLY:N	1.80	0.96
1:A:214:MET:SD	8:A:707:HOH:O	2.28	0.90
1:A:214:MET:CE	1:A:234:GLY:H	1.88	0.80
1:A:207:MET:HE3	1:B:264:PRO:HG3	1.65	0.77

All (1) symmetry-related close contacts are listed below. The label for Atom-2 includes the symmetry operator and encoded unit-cell translations to be applied.

Atom-1	Atom-2	Interatomic distance (Å)	Clash overlap (Å)
1:A:306:LYS:NZ	1:B:337:GLU:OE2[1_554]	2.10	0.10

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	167/177 (94%)	164 (98%)	3 (2%)	0	100	100
1	B	168/177 (95%)	164 (98%)	4 (2%)	0	100	100
2	C	76/105 (72%)	74 (97%)	2 (3%)	0	100	100
2	D	76/105 (72%)	76 (100%)	0	0	100	100
All	All	487/564 (86%)	478 (98%)	9 (2%)	0	100	100

There are no Ramachandran outliers to report.

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	140/148 (95%)	139 (99%)	1 (1%)	76	66
1	B	141/148 (95%)	140 (99%)	1 (1%)	76	66
2	C	70/90 (78%)	69 (99%)	1 (1%)	59	44
2	D	70/90 (78%)	69 (99%)	1 (1%)	59	44
All	All	421/476 (88%)	417 (99%)	4 (1%)	68	55

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

Mol	Chain	Res	Type
1	A	189	LYS
1	B	211	VAL
2	C	97	GLU
2	D	97	GLU

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

Mol	Chain	Res	Type
1	B	232	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 ⓘ

There are no oligosaccharides in this entry.

5.6 Ligand geometry ⓘ

Of 12 ligands modelled in this entry, 3 are monoatomic - leaving 9 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$
5	SIN	A	503	-	7,7,7	1.04	0	8,8,8	2.01	3 (37%)
4	EPE	B	401	-	15,15,15	1.68	3 (20%)	19,20,20	1.38	3 (15%)
3	EDO	A	501	-	3,3,3	0.31	0	2,2,2	1.02	0
3	EDO	D	201	-	3,3,3	0.41	0	2,2,2	0.38	0
4	EPE	A	502	-	15,15,15	1.58	3 (20%)	19,20,20	1.04	1 (5%)
4	EPE	B	402	-	15,15,15	1.80	3 (20%)	19,20,20	1.49	3 (15%)
3	EDO	C	201	-	3,3,3	0.43	0	2,2,2	0.40	0
3	EDO	D	202	-	3,3,3	0.51	0	2,2,2	0.28	0
7	FMT	C	202	-	2,2,2	0.63	0	1,1,1	0.04	0

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
5	SIN	A	503	-	-	0/5/5/5	-
4	EPE	B	401	-	-	0/9/19/19	0/1/1/1
3	EDO	A	501	-	-	0/1/1/1	-
3	EDO	D	201	-	-	0/1/1/1	-
4	EPE	A	502	-	-	0/9/19/19	0/1/1/1
4	EPE	B	402	-	-	3/9/19/19	0/1/1/1
3	EDO	C	201	-	-	1/1/1/1	-
3	EDO	D	202	-	-	1/1/1/1	-

The worst 5 of 9 bond length outliers are listed below:

Mol	Chain	Res	Type	Atoms	Z	Observed(Å)	Ideal(Å)
4	B	402	EPE	C10-S	4.75	1.84	1.77
4	B	401	EPE	C10-S	4.10	1.83	1.77
4	B	401	EPE	O1S-S	3.59	1.55	1.45
4	A	502	EPE	O2S-S	3.36	1.54	1.45
4	A	502	EPE	C10-S	3.21	1.82	1.77

The worst 5 of 10 bond angle outliers are listed below:

Mol	Chain	Res	Type	Atoms	Z	Observed(°)	Ideal(°)
5	A	503	SIN	C2-C3-C4	-3.50	104.38	113.67
4	B	401	EPE	O2S-S-C10	3.44	111.92	106.73
4	B	402	EPE	O2S-S-O1S	-2.88	104.46	113.82
4	B	402	EPE	O3S-S-C10	2.62	111.14	106.00
5	A	503	SIN	O1-C1-C2	-2.52	115.09	123.09

There are no chirality outliers.

All (5) torsion outliers are listed below:

Mol	Chain	Res	Type	Atoms
4	B	402	EPE	C9-C10-S-O2S
4	B	402	EPE	C9-C10-S-O3S
4	B	402	EPE	C9-C10-S-O1S
3	D	202	EDO	O1-C1-C2-O2
3	C	201	EDO	O1-C1-C2-O2

There are no ring outliers.

4 monomers are involved in 5 short contacts:

Mol	Chain	Res	Type	Clashes	Symm-Clashes
4	B	401	EPE	1	0

Continued on next page...

Continued from previous page...

Mol	Chain	Res	Type	Clashes	Symm-Clashes
3	A	501	EDO	1	0
3	D	201	EDO	1	0
4	B	402	EPE	2	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	167/177 (94%)	-0.28	1 (0%) 85 89	10, 24, 42, 57	3 (1%)
1	B	167/177 (94%)	-0.21	0 100 100	10, 24, 40, 59	5 (2%)
2	C	76/105 (72%)	-0.08	1 (1%) 75 81	12, 24, 42, 70	5 (6%)
2	D	75/105 (71%)	-0.15	0 100 100	14, 25, 44, 58	5 (6%)
All	All	485/564 (85%)	-0.20	2 (0%) 88 92	10, 24, 42, 70	18 (3%)

All (2) RSRZ outliers are listed below:

Mol	Chain	Res	Type	RSRZ
2	C	98	LEU	5.3
1	A	341	VAL	3.2

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
5	SIN	A	503	8/8	0.73	0.20	43,59,67,67	0
4	EPE	B	402	15/15	0.74	0.17	43,66,96,96	0
7	FMT	C	202	3/3	0.82	0.12	49,49,50,51	0
6	CL	B	403	1/1	0.86	0.20	72,72,72,72	0
3	EDO	A	501	4/4	0.86	0.14	33,34,36,44	0
4	EPE	A	502	15/15	0.87	0.13	34,50,66,68	0
4	EPE	B	401	15/15	0.88	0.15	42,48,56,57	0
3	EDO	C	201	4/4	0.89	0.11	46,46,49,53	0
3	EDO	D	202	4/4	0.90	0.11	50,51,52,54	0
6	CL	D	203	1/1	0.94	0.08	53,53,53,53	0
3	EDO	D	201	4/4	0.94	0.08	32,36,36,40	0
6	CL	C	203	1/1	0.96	0.08	55,55,55,55	0

6.5 Other polymers [i](#)

There are no such residues in this entry.