



Full wwPDB X-ray Structure Validation Report ⓘ

Mar 8, 2026 – 04:44 PM UTC

PDB ID : 1E49 / pdb_00001e49
Title : L-Fucose 1-Phosphate Aldolase from Escherichia coli Mutant N29L/S71A
Authors : Joerger, A.C.; Schulz, G.E.
Deposited on : 2000-06-30
Resolution : 2.53 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
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

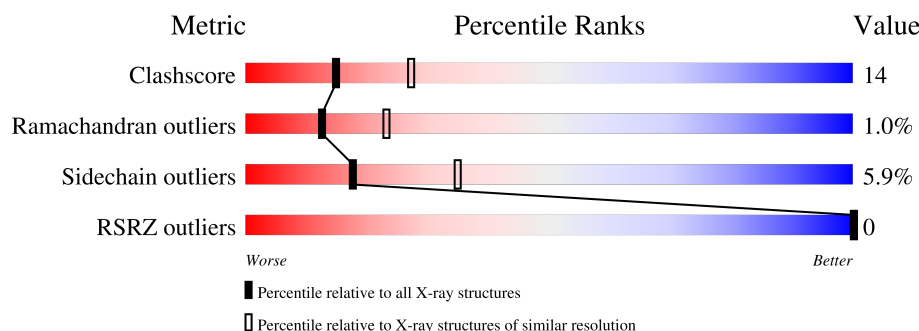
1 Overall quality at a glance

The following experimental techniques were used to determine the structure:

X-RAY DIFFRACTION

The reported resolution of this entry is 2.53 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	8079 (2.54-2.50)
Ramachandran outliers	187476	7944 (2.54-2.50)
Sidechain outliers	187428	7946 (2.54-2.50)
RSRZ outliers	180081	7387 (2.54-2.50)

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 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	P	215	52% 30% 13% ..

2 Entry composition [i](#)

There are 5 unique types of molecules in this entry. The entry contains 1707 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 L-FUCULOSE 1-PHOSPHATE ALDOLASE.

Mol	Chain	Residues	Atoms					ZeroOcc	AltConf	Trace
			Total	C	N	O	S			
1	P	206	1607	1022	280	294	11	0	5	0

There are 2 discrepancies between the modelled and reference sequences:

Chain	Residue	Modelled	Actual	Comment	Reference
P	29	LEU	ASN	engineered mutation	UNP P11550
P	71	ALA	SER	engineered mutation	UNP P11550

- Molecule 2 is SULFATE ION (CCD ID: SO4) (formula: O₄S).



Mol	Chain	Residues	Atoms			ZeroOcc	AltConf
			Total	O	S		
2	P	1	5	4	1	0	0

- Molecule 3 is BETA-MERCAPTOETHANOL (CCD ID: BME) (formula: C₂H₆OS).



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

- Molecule 4 is ZINC ION (CCD ID: ZN) (formula: Zn).

Mol	Chain	Residues	Atoms		ZeroOcc	AltConf
4	P	1	Total	Zn	0	0
			1	1		

- Molecule 5 is water.

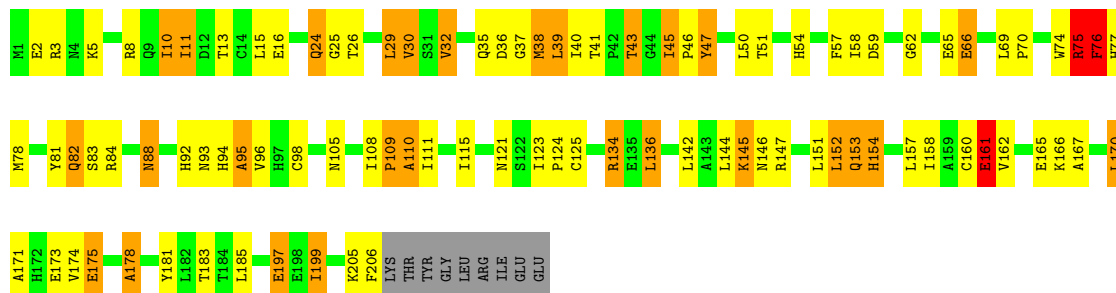
Mol	Chain	Residues	Atoms		ZeroOcc	AltConf
5	P	90	Total	O	0	0
			90	90		

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: L-FUCULOSE 1-PHOSPHATE ALDOLASE

Chain P: 



4 Data and refinement statistics

Property	Value	Source
Space group	P 4 21 2	Depositor
Cell constants a, b, c, α , β , γ	93.75Å 93.75Å 43.50Å 90.00° 90.00° 90.00°	Depositor
Resolution (Å)	10.00 – 2.53 10.00 – 2.53	Depositor EDS
% Data completeness (in resolution range)	92.0 (10.00-2.53) 90.7 (10.00-2.53)	Depositor EDS
R_{merge}	(Not available)	Depositor
R_{sym}	0.08	Depositor
$\langle I/\sigma(I) \rangle$ ¹	5.32 (at 2.53Å)	Xtriage
Refinement program	REFMAC	Depositor
R, R_{free}	0.142 , (Not available) 0.143 , (Not available)	Depositor DCC
R_{free} test set	No test flags present.	wwPDB-VP
Wilson B-factor (Å ²)	24.9	Xtriage
Anisotropy	0.487	Xtriage
Bulk solvent k_{sol} (e/Å ³), B_{sol} (Å ²)	0.33 , 69.8	EDS
L-test for twinning ²	$\langle L \rangle = 0.46$, $\langle L^2 \rangle = 0.29$	Xtriage
Estimated twinning fraction	No twinning to report.	Xtriage
F_o, F_c correlation	0.96	EDS
Total number of atoms	1707	wwPDB-VP
Average B, all atoms (Å ²)	25.0	wwPDB-VP

Xtriage's analysis on translational NCS is as follows: *The largest off-origin peak in the Patterson function is 6.36% 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: ZN, SO4, BME

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	P	0.89	0/1660	2.23	83/2258 (3.7%)

There are no bond length outliers.

All (83) bond angle outliers are listed below:

Mol	Chain	Res	Type	Atoms	Z	Observed(°)	Ideal(°)
1	P	109	PRO	O-C-N	-10.46	110.49	123.04
1	P	30	VAL	CA-C-O	-9.77	109.73	120.67
1	P	77	HIS	N-CA-C	-8.93	100.51	111.40
1	P	26	THR	CA-C-O	8.92	131.89	121.28
1	P	8	ARG	CD-NE-CZ	8.67	136.53	124.40
1	P	25	GLY	CA-C-N	8.33	133.93	122.19
1	P	25	GLY	C-N-CA	8.33	133.93	122.19
1	P	32	VAL	O-C-N	8.32	132.28	123.04
1	P	38	MET	O-C-N	8.02	132.32	123.10
1	P	35	GLN	CB-CG-CD	7.56	125.45	112.60
1	P	206	PHE	CA-CB-CG	7.45	121.25	113.80
1	P	157	LEU	CA-CB-CG	7.41	142.23	116.30
1	P	105	ASN	O-C-N	-7.34	113.77	122.58
1	P	146	ASN	N-CA-CB	-7.06	101.31	111.54
1	P	76	PHE	CA-CB-CG	6.90	120.70	113.80
1	P	96[A]	VAL	N-CA-C	6.75	117.51	110.62
1	P	96[B]	VAL	N-CA-C	6.75	117.51	110.62
1	P	154	HIS	CA-CB-CG	-6.71	107.09	113.80
1	P	108	ILE	CB-CA-C	-6.66	103.18	111.04
1	P	32	VAL	CA-C-O	-6.62	114.72	121.67
1	P	145	LYS	CA-C-O	-6.62	113.81	120.90
1	P	59	ASP	CA-CB-CG	6.49	119.09	112.60
1	P	125	CYS	CA-C-O	-6.49	113.36	120.30
1	P	178	ALA	CA-C-O	6.39	128.50	121.02

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Mol	Chain	Res	Type	Atoms	Z	Observed(°)	Ideal(°)
1	P	178	ALA	O-C-N	-6.38	114.48	122.20
1	P	74	TRP	N-CA-C	6.37	119.52	111.69
1	P	83	SER	N-CA-CB	-6.36	100.79	110.33
1	P	39	LEU	CA-C-O	-6.36	113.56	120.36
1	P	161	GLU	CA-CB-CG	6.36	126.82	114.10
1	P	88	ASN	OD1-CG-ND2	-6.25	116.34	122.60
1	P	151	LEU	CA-C-N	-6.23	113.98	122.77
1	P	151	LEU	C-N-CA	-6.23	113.98	122.77
1	P	75	ARG	CA-CB-CG	6.11	126.32	114.10
1	P	81	TYR	O-C-N	6.08	129.75	122.27
1	P	153	GLN	N-CA-C	6.08	119.17	110.24
1	P	197	GLU	CB-CA-C	-6.01	100.64	110.85
1	P	173	GLU	O-C-N	-5.96	115.80	122.12
1	P	13	THR	CA-C-O	-5.95	114.11	120.42
1	P	10	ILE	N-CA-C	-5.78	104.29	110.36
1	P	167	ALA	CA-C-O	-5.75	114.79	120.82
1	P	32	VAL	CB-CA-C	-5.71	101.88	110.55
1	P	66	GLU	CA-CB-CG	5.66	125.41	114.10
1	P	13	THR	N-CA-C	-5.65	105.20	111.36
1	P	145	LYS	CA-C-N	-5.62	112.28	122.50
1	P	145	LYS	C-N-CA	-5.62	112.28	122.50
1	P	45	ILE	N-CA-C	5.62	121.01	108.88
1	P	24	GLN	CA-C-O	-5.58	112.53	120.07
1	P	95	ALA	CA-C-O	-5.58	115.37	120.95
1	P	98	CYS	CA-C-N	5.54	127.97	120.38
1	P	98	CYS	C-N-CA	5.54	127.97	120.38
1	P	16	GLU	O-C-N	-5.54	115.83	122.15
1	P	146	ASN	N-CA-C	5.50	119.14	111.56
1	P	167	ALA	N-CA-C	-5.46	105.23	111.07
1	P	16	GLU	CA-C-N	5.43	128.11	120.28
1	P	16	GLU	C-N-CA	5.43	128.11	120.28
1	P	36	ASP	CA-CB-CG	-5.43	107.17	112.60
1	P	37	GLY	CA-C-N	-5.41	112.99	121.87
1	P	37	GLY	C-N-CA	-5.41	112.99	121.87
1	P	142	LEU	CA-C-N	5.40	128.06	120.28
1	P	142	LEU	C-N-CA	5.40	128.06	120.28
1	P	43	THR	N-CA-CB	5.37	119.16	110.41
1	P	81	TYR	CA-C-O	-5.36	113.80	119.97
1	P	29	LEU	N-CA-CB	5.36	120.83	111.13
1	P	124	PRO	CA-C-N	-5.34	115.47	123.00
1	P	124	PRO	C-N-CA	-5.34	115.47	123.00
1	P	175	GLU	CA-CB-CG	5.29	124.69	114.10

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Mol	Chain	Res	Type	Atoms	Z	Observed(°)	Ideal(°)
1	P	121	ASN	CA-CB-CG	5.28	117.88	112.60
1	P	199	ILE	CA-C-O	-5.28	114.92	120.57
1	P	62	GLY	N-CA-C	-5.25	107.97	115.64
1	P	167	ALA	N-CA-CB	5.25	117.62	110.01
1	P	152	LEU	CA-CB-CG	5.22	134.57	116.30
1	P	134	ARG	CA-CB-CG	5.21	124.53	114.10
1	P	26	THR	N-CA-C	-5.20	104.72	111.74
1	P	197	GLU	N-CA-CB	5.17	117.81	110.16
1	P	161	GLU	CB-CG-CD	5.17	121.38	112.60
1	P	82	GLN	CB-CG-CD	5.15	121.36	112.60
1	P	183	THR	N-CA-CB	-5.13	102.37	110.06
1	P	147	ARG	NE-CZ-NH1	-5.04	116.46	121.50
1	P	29	LEU	CA-CB-CG	5.04	133.92	116.30
1	P	171	ALA	O-C-N	5.04	127.89	122.15
1	P	145	LYS	N-CA-CB	5.03	117.44	109.94
1	P	11	ILE	N-CA-C	5.02	115.74	110.62
1	P	30	VAL	O-C-N	5.01	128.46	123.10

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	P	1607	0	1623	45	0
2	P	5	0	0	1	0
3	P	4	0	5	0	0
4	P	1	0	0	0	0
5	P	90	0	0	2	0
All	All	1707	0	1628	45	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 14.

All (45) 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:P:58:ILE:HD11	1:P:70:PRO:HB3	1.62	0.81
1:P:161:GLU:HG3	1:P:166:LYS:HB3	1.69	0.75
1:P:24:GLN:HB2	5:P:419:HOH:O	1.89	0.71
1:P:29:LEU:HD13	1:P:92:HIS:HD2	1.62	0.65
1:P:88:ASN:HB2	1:P:162:VAL:O	2.00	0.61
1:P:76:PHE:CE1	1:P:158[B]:ILE:HD11	2.35	0.61
1:P:40:ILE:HG12	1:P:41:THR:N	2.16	0.60
1:P:69:LEU:HD22	1:P:69:LEU:N	2.17	0.60
1:P:47:TYR:O	1:P:50:LEU:HB2	2.02	0.59
1:P:3:ARG:HH22	1:P:65:GLU:CD	2.15	0.55
1:P:84:ARG:HD3	1:P:160[B]:CYS:SG	2.47	0.54
1:P:29:LEU:HD23	1:P:40:ILE:HD11	1.90	0.54
1:P:109:PRO:O	1:P:111:ILE:N	2.41	0.52
1:P:38:MET:HE2	1:P:78[B]:MET:HE2	1.92	0.52
1:P:161:GLU:OE1	1:P:162:VAL:HG13	2.10	0.51
1:P:153:GLN:O	1:P:154:HIS:HB2	2.10	0.51
1:P:29:LEU:HD13	1:P:92:HIS:CD2	2.43	0.50
1:P:181:TYR:O	1:P:185:LEU:HB2	2.12	0.50
1:P:170:LEU:O	1:P:174:VAL:HG23	2.13	0.49
1:P:94:HIS:O	1:P:95:ALA:C	2.55	0.48
1:P:43:THR:HG22	1:P:69:LEU:HB2	1.95	0.47
1:P:165:GLU:HG3	5:P:445:HOH:O	2.14	0.47
1:P:45:ILE:HD13	1:P:54:HIS:CD2	2.50	0.47
1:P:29:LEU:CD1	1:P:92:HIS:HD2	2.29	0.46
1:P:78[A]:MET:HE3	1:P:82:GLN:HE22	1.81	0.45
1:P:10:ILE:HG12	1:P:30:VAL:HG12	1.99	0.45
1:P:40:ILE:HG12	1:P:41:THR:H	1.79	0.44
1:P:15:LEU:HD12	1:P:47:TYR:HD2	1.83	0.44
1:P:45:ILE:HG22	1:P:50:LEU:HG	1.99	0.43
1:P:57:PHE:H	1:P:65:GLU:HG3	1.82	0.43
1:P:92:HIS:O	1:P:93:ASN:HB3	2.18	0.43
1:P:115:ILE:HD11	1:P:123:ILE:HG12	2.01	0.43
1:P:45:ILE:HA	1:P:46:PRO:HD2	1.88	0.42
1:P:51:THR:N	1:P:54:HIS:ND1	2.51	0.42
1:P:32:VAL:HG22	1:P:39:LEU:HB2	2.02	0.42
1:P:175:GLU:O	1:P:178:ALA:HB3	2.20	0.42
1:P:11:ILE:HD13	1:P:50:LEU:HB3	2.01	0.41
1:P:110:ALA:HB1	1:P:199:ILE:HD11	2.02	0.41
1:P:2:GLU:O	1:P:3:ARG:C	2.63	0.41
1:P:144:LEU:O	1:P:145:LYS:C	2.61	0.41
1:P:3:ARG:NH2	1:P:65:GLU:OE1	2.48	0.41
1:P:76:PHE:CD2	1:P:136:LEU:HD13	2.56	0.41

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Atom-1	Atom-2	Interatomic distance (Å)	Clash overlap (Å)
1:P:152:LEU:HD11	1:P:158[A]:ILE:HG13	2.03	0.40
1:P:75:ARG:NH1	2:P:301:SO4:O2	2.51	0.40
1:P:76:PHE:HD2	1:P:136:LEU:HD13	1.86	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	P	209/215 (97%)	198 (95%)	9 (4%)	2 (1%)	12 23

All (2) Ramachandran outliers are listed below:

Mol	Chain	Res	Type
1	P	110	ALA
1	P	47	TYR

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	P	175/178 (98%)	165 (94%)	10 (6%)	18 36

All (10) residues with a non-rotameric sidechain are listed below:

Mol	Chain	Res	Type
1	P	5	LYS
1	P	66	GLU
1	P	75	ARG
1	P	76	PHE
1	P	134	ARG
1	P	136	LEU
1	P	161	GLU
1	P	170	LEU
1	P	197	GLU
1	P	205	LYS

Sometimes sidechains can be flipped to improve hydrogen bonding and reduce clashes. All (3) such sidechains are listed below:

Mol	Chain	Res	Type
1	P	82	GLN
1	P	121	ASN
1	P	172	HIS

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, 1 is monoatomic - leaving 2 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	BME	P	302	1	3,3,3	0.60	0	2,2,2	0.13	0
2	SO4	P	301	-	4,4,4	0.74	0	6,6,6	0.52	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
3	BME	P	302	1	-	1/1/1/1	-

There are no bond length outliers.

There are no bond angle outliers.

There are no chirality outliers.

All (1) torsion outliers are listed below:

Mol	Chain	Res	Type	Atoms
3	P	302	BME	O1-C1-C2-S2

There are no ring outliers.

1 monomer is involved in 1 short contact:

Mol	Chain	Res	Type	Clashes	Symm-Clashes
2	P	301	SO4	1	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	P	206/215 (95%)	-0.94	0 100 100	5, 20, 50, 60	5 (2%)

There are no RSRZ outliers to report.

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	SO4	P	301	5/5	0.94	0.08	49,49,50,51	5
3	BME	P	302	4/4	0.96	0.10	29,34,40,46	0
4	ZN	P	303	1/1	1.00	0.02	17,17,17,17	0

6.5 Other polymers [i](#)

There are no such residues in this entry.