



wwPDB X-ray Structure Validation Summary Report ⓘ

Mar 17, 2026 – 06:51 PM UTC

PDB ID : 6EXH / pdb_00006exh
Title : Crystal structure of the complex Fe(II)/alpha-ketoglutarate dependent dioxxygenase KDO5 with Fe(II)/succinate/(4R)-4-hydroxy-L-lysine
Authors : Isabet, T.; Stura, E.; Legrand, P.; Zaparucha, A.; Bastard, K.
Deposited on : 2017-11-08
Resolution : 2.60 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

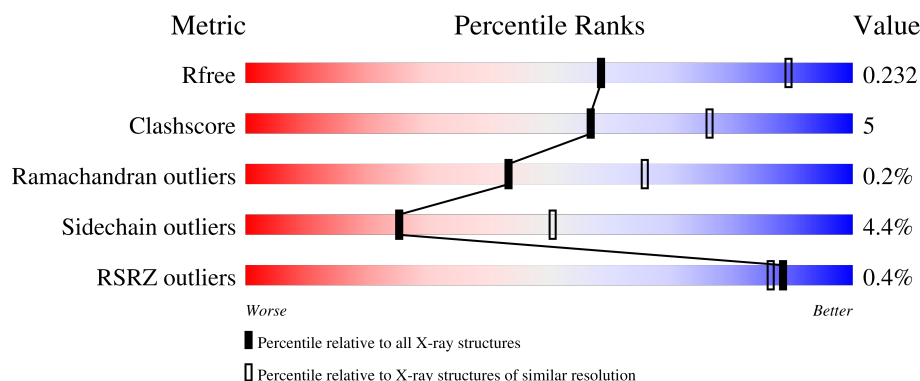
1 Overall quality at a glance

The following experimental techniques were used to determine the structure:

X-RAY DIFFRACTION

The reported resolution of this entry is 2.60 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	4008 (2.60-2.60)
Clashscore	190562	4347 (2.60-2.60)
Ramachandran outliers	187476	4277 (2.60-2.60)
Sidechain outliers	187428	4277 (2.60-2.60)
RSRZ outliers	180081	4008 (2.60-2.60)

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	372	 81% 11% • 6%
1	B	372	 75% 14% • 10%
1	C	372	 79% 16% • 5%
1	D	372	 81% 13% 6%

The following table lists non-polymeric compounds, carbohydrate monomers and non-standard

residues in protein, DNA, RNA chains that are outliers for geometric or electron-density-fit criteria:

Mol	Type	Chain	Res	Chirality	Geometry	Clashes	Electron density
4	SIN	A	403	-	X	-	-
4	SIN	D	402[A]	-	X	-	-

2 Entry composition

There are 6 unique types of molecules in this entry. The entry contains 11611 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.

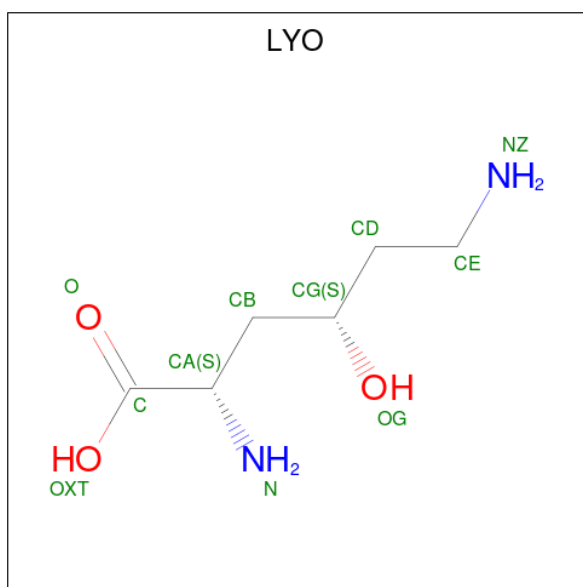
- Molecule 1 is a protein called L-lysine 4-hydroxylase.

Mol	Chain	Residues	Atoms					ZeroOcc	AltConf	Trace
1	A	348	Total	C	N	O	S	0	5	0
			2799	1776	479	531	13			
1	B	336	Total	C	N	O	S	0	5	0
			2703	1721	462	507	13			
1	C	353	Total	C	N	O	S	0	3	0
			2817	1788	481	535	13			
1	D	350	Total	C	N	O	S	0	0	0
			2768	1759	472	525	12			

- Molecule 2 is FE (III) ION (CCD ID: FE) (formula: Fe).

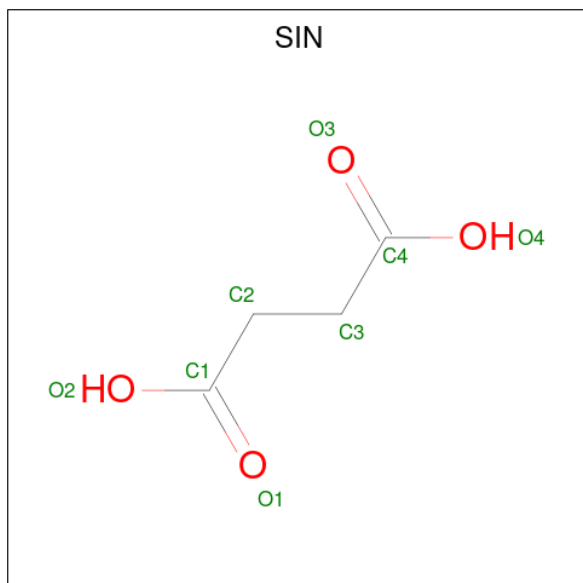
Mol	Chain	Residues	Atoms		ZeroOcc	AltConf
2	A	1	Total	Fe	0	0
			1	1		
2	B	1	Total	Fe	0	0
			1	1		
2	C	1	Total	Fe	0	0
			1	1		
2	D	1	Total	Fe	0	0
			1	1		

- Molecule 3 is 4-HYDROXY-LYSINE (CCD ID: LYO) (formula: C₆H₁₄N₂O₃).



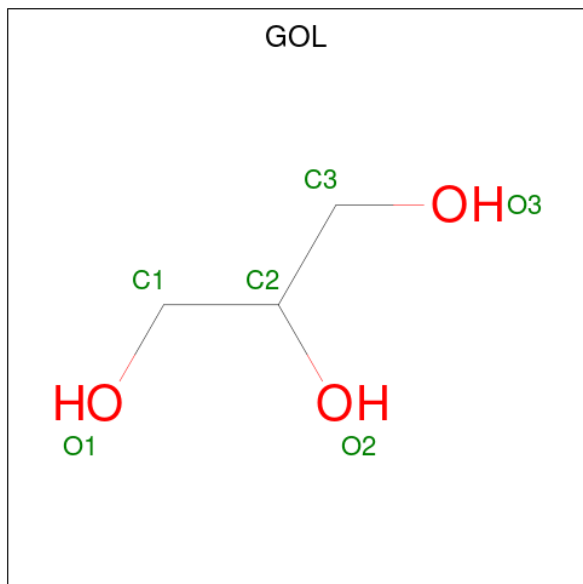
Mol	Chain	Residues	Atoms				ZeroOcc	AltConf
3	A	1	Total	C	N	O	0	1
			11	6	2	3		
3	B	1	Total	C	N	O	0	1
			11	6	2	3		
3	C	1	Total	C	N	O	0	0
			11	6	2	3		
3	D	1	Total	C	N	O	0	0
			11	6	2	3		

- Molecule 4 is SUCCINIC ACID (CCD ID: SIN) (formula: C₄H₆O₄).



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

- Molecule 5 is GLYCEROL (CCD ID: GOL) (formula: $C_3H_8O_3$).



Mol	Chain	Residues	Atoms			ZeroOcc	AltConf
5	A	1	Total	C	O	0	0
			6	3	3		
5	C	1	Total	C	O	0	0
			6	3	3		
5	D	1	Total	C	O	0	0
			6	3	3		

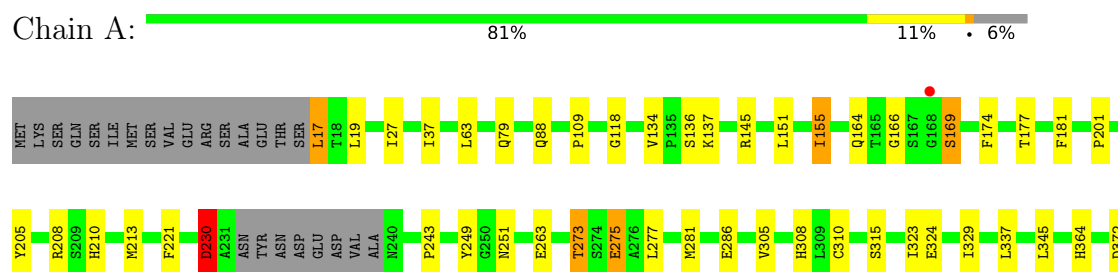
- Molecule 6 is water.

Mol	Chain	Residues	Atoms		ZeroOcc	AltConf
6	A	159	Total	O	0	2
			159	159		
6	B	96	Total	O	0	2
			96	96		
6	C	78	Total	O	0	0
			78	78		
6	D	101	Total	O	0	2
			101	101		

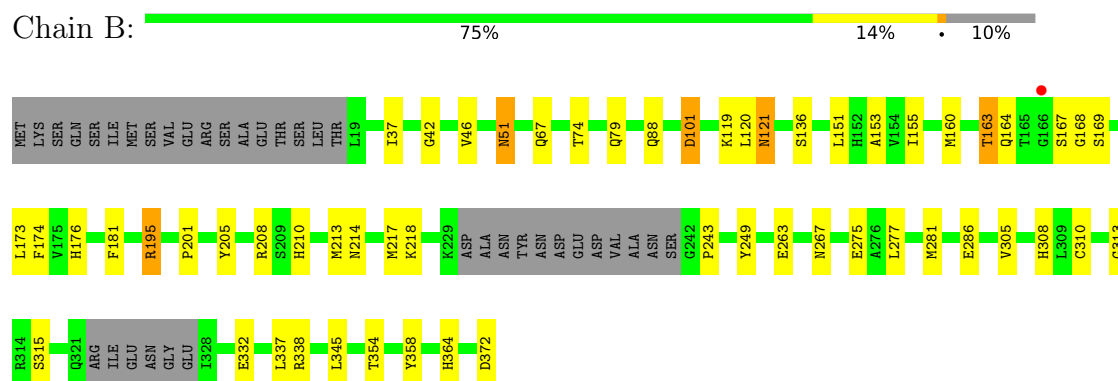
3 Residue-property plots

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.

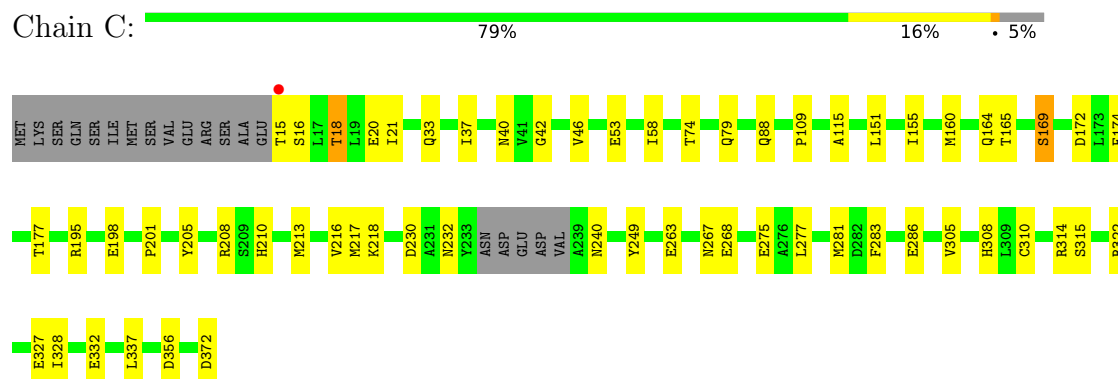
- Molecule 1: L-lysine 4-hydroxylase



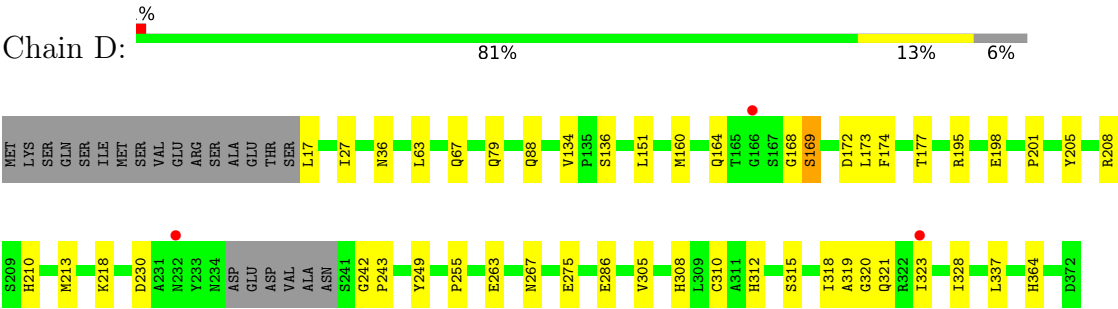
- Molecule 1: L-lysine 4-hydroxylase



- Molecule 1: L-lysine 4-hydroxylase



- Molecule 1: L-lysine 4-hydroxylase



4 Data and refinement statistics

Property	Value	Source
Space group	P 21 21 21	Depositor
Cell constants a, b, c, α , β , γ	91.74Å 99.23Å 165.58Å 90.00° 90.00° 90.00°	Depositor
Resolution (Å)	38.07 – 2.60 38.07 – 2.60	Depositor EDS
% Data completeness (in resolution range)	100.0 (38.07-2.60) 99.9 (38.07-2.60)	Depositor EDS
R_{merge}	(Not available)	Depositor
R_{sym}	(Not available)	Depositor
$\langle I/\sigma(I) \rangle$ ¹	1.86 (at 2.61Å)	Xtriage
Refinement program	BUSTER 2.10.3	Depositor
R, R_{free}	0.177 , 0.226 0.183 , 0.232	Depositor DCC
R_{free} test set	2363 reflections (5.00%)	wwPDB-VP
Wilson B-factor (Å ²)	62.0	Xtriage
Anisotropy	0.616	Xtriage
Bulk solvent k_{sol} (e/Å ³), B_{sol} (Å ²)	0.33 , 70.0	EDS
L-test for twinning ²	$\langle L \rangle = 0.48$, $\langle L^2 \rangle = 0.31$	Xtriage
Estimated twinning fraction	No twinning to report.	Xtriage
F_o, F_c correlation	0.96	EDS
Total number of atoms	11611	wwPDB-VP
Average B, all atoms (Å ²)	79.0	wwPDB-VP

Xtriage's analysis on translational NCS is as follows: *The largest off-origin peak in the Patterson function is 9.99% 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: FE, GOL, SIN, LYO

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	0.90	2/2862 (0.1%)	1.33	7/3872 (0.2%)
1	B	0.87	0/2765	1.34	8/3740 (0.2%)
1	C	0.86	0/2880	1.36	13/3897 (0.3%)
1	D	0.87	1/2831 (0.0%)	1.32	7/3834 (0.2%)
All	All	0.87	3/11338 (0.0%)	1.34	35/15343 (0.2%)

All (3) bond length outliers are listed below:

Mol	Chain	Res	Type	Atoms	Z	Observed(Å)	Ideal(Å)
1	D	134	VAL	CA-C	6.76	1.58	1.52
1	A	134	VAL	CA-CB	5.24	1.56	1.54
1	A	155	ILE	CA-C	5.15	1.56	1.52

The worst 5 of 35 bond angle outliers are listed below:

Mol	Chain	Res	Type	Atoms	Z	Observed(°)	Ideal(°)
1	C	230	ASP	CA-CB-CG	9.29	121.89	112.60
1	D	230	ASP	CA-CB-CG	8.98	121.58	112.60
1	C	328	ILE	N-CA-CB	6.74	118.31	110.82
1	D	169	SER	CA-C-N	6.69	130.14	120.38
1	D	169	SER	C-N-CA	6.69	130.14	120.38

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	2799	0	2731	28	0
1	B	2703	0	2649	32	0
1	C	2817	0	2755	27	0
1	D	2768	0	2697	19	0
2	A	1	0	0	0	0
2	B	1	0	0	0	0
2	C	1	0	0	0	0
2	D	1	0	0	0	0
3	A	11	0	13	2	0
3	B	11	0	13	2	0
3	C	11	0	13	1	0
3	D	11	0	13	1	0
4	A	8	0	4	0	0
4	B	8	0	4	0	0
4	D	8	0	4	1	0
5	A	6	0	8	0	0
5	C	6	0	8	1	0
5	D	6	0	8	0	0
6	A	159	0	0	0	0
6	B	96	0	0	0	0
6	C	78	0	0	0	0
6	D	101	0	0	0	0
All	All	11611	0	10920	101	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 5.

The worst 5 of 101 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:B:213[B]:MET:HE1	1:B:217:MET:CE	2.09	0.83
1:B:213[B]:MET:HE1	1:B:217:MET:HE1	1.71	0.72
1:B:213[A]:MET:HG3	1:B:218:LYS:HE3	1.73	0.71
1:B:213[B]:MET:HE1	1:B:217:MET:HE2	1.74	0.68
1:C:217[A]:MET:HE1	1:C:283:PHE:HD1	1.60	0.66

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	349/372 (94%)	333 (95%)	15 (4%)	1 (0%)	36	58
1	B	335/372 (90%)	323 (96%)	12 (4%)	0	100	100
1	C	352/372 (95%)	341 (97%)	11 (3%)	0	100	100
1	D	346/372 (93%)	332 (96%)	12 (4%)	2 (1%)	21	42
All	All	1382/1488 (93%)	1329 (96%)	50 (4%)	3 (0%)	43	66

All (3) Ramachandran outliers are listed below:

Mol	Chain	Res	Type
1	A	230	ASP
1	D	319	ALA
1	D	242	GLY

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	305/322 (95%)	292 (96%)	13 (4%)	26	51
1	B	295/322 (92%)	281 (95%)	14 (5%)	23	48
1	C	307/322 (95%)	292 (95%)	15 (5%)	22	47
1	D	300/322 (93%)	289 (96%)	11 (4%)	30	57
All	All	1207/1288 (94%)	1154 (96%)	53 (4%)	25	50

5 of 53 residues with a non-rotameric sidechain are listed below:

Mol	Chain	Res	Type
1	C	18	THR
1	C	263	GLU
1	D	263	GLU
1	C	20	GLU
1	C	172	ASP

Sometimes sidechains can be flipped to improve hydrogen bonding and reduce clashes. 5 of 39 such sidechains are listed below:

Mol	Chain	Res	Type
1	C	267	ASN
1	D	226	GLN
1	C	308	HIS
1	D	164	GLN
1	D	308	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 14 ligands modelled in this entry, 4 are monoatomic - leaving 10 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	LYO	B	402[A]	-	8,10,10	1.52	2 (25%)	8,12,12	0.71	0
4	SIN	A	403	2	7,7,7	2.00	4 (57%)	8,8,8	2.24	4 (50%)
4	SIN	B	403	2	7,7,7	0.26	0	8,8,8	0.15	0
3	LYO	D	404	-	8,10,10	0.10	0	8,12,12	0.52	0
3	LYO	C	402	-	8,10,10	0.19	0	8,12,12	0.50	0
4	SIN	D	402[A]	2	7,7,7	2.22	4 (57%)	8,8,8	1.90	4 (50%)
3	LYO	A	402[A]	-	8,10,10	1.52	2 (25%)	8,12,12	1.48	1 (12%)
5	GOL	C	403	-	5,5,5	0.09	0	5,5,5	0.31	0
5	GOL	D	403	-	5,5,5	0.10	0	5,5,5	0.29	0
5	GOL	A	404	-	5,5,5	0.13	0	5,5,5	0.32	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	LYO	B	402[A]	-	-	5/11/11/11	-
4	SIN	A	403	2	-	3/5/5/5	-
4	SIN	B	403	2	-	5/5/5/5	-
3	LYO	D	404	-	-	5/11/11/11	-
3	LYO	C	402	-	-	3/11/11/11	-
4	SIN	D	402[A]	2	-	5/5/5/5	-
3	LYO	A	402[A]	-	-	5/11/11/11	-
5	GOL	C	403	-	-	1/4/4/4	-
5	GOL	D	403	-	-	0/4/4/4	-
5	GOL	A	404	-	-	0/4/4/4	-

The worst 5 of 12 bond length outliers are listed below:

Mol	Chain	Res	Type	Atoms	Z	Observed(Å)	Ideal(Å)
4	D	402[A]	SIN	O3-C4	3.41	1.33	1.22
3	A	402[A]	LYO	O-C	3.41	1.32	1.22
3	B	402[A]	LYO	O-C	3.30	1.31	1.22
4	D	402[A]	SIN	O1-C1	3.03	1.32	1.22
4	A	403	SIN	O1-C1	2.84	1.31	1.22

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

Mol	Chain	Res	Type	Atoms	Z	Observed(°)	Ideal(°)
4	A	403	SIN	O2-C1-C2	3.32	124.49	114.00
4	A	403	SIN	O1-C1-C2	-3.32	112.58	123.09
3	A	402[A]	LYO	CG-CB-CA	3.29	119.98	114.42
4	A	403	SIN	O3-C4-C3	-3.04	113.45	123.09
4	A	403	SIN	O4-C4-C3	2.96	123.34	114.00

There are no chirality outliers.

5 of 32 torsion outliers are listed below:

Mol	Chain	Res	Type	Atoms
3	A	402[A]	LYO	O-C-CA-N
3	B	402[A]	LYO	N-CA-CB-CG
3	D	404	LYO	O-C-CA-N
3	D	404	LYO	CG-CD-CE-NZ
4	D	402[A]	SIN	C1-C2-C3-C4

There are no ring outliers.

6 monomers are involved in 8 short contacts:

Mol	Chain	Res	Type	Clashes	Symm-Clashes
3	B	402[A]	LYO	2	0
3	D	404	LYO	1	0
3	C	402	LYO	1	0
4	D	402[A]	SIN	1	0
3	A	402[A]	LYO	2	0
5	C	403	GOL	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	A	348/372 (93%)	-0.40	1 (0%) 90 88	29, 64, 111, 139	5 (1%)
1	B	336/372 (90%)	-0.24	1 (0%) 90 88	27, 73, 136, 163	5 (1%)
1	C	353/372 (94%)	-0.21	1 (0%) 90 88	33, 78, 121, 155	3 (0%)
1	D	350/372 (94%)	-0.28	3 (0%) 81 78	49, 76, 142, 206	0
All	All	1387/1488 (93%)	-0.29	6 (0%) 88 86	27, 73, 127, 206	13 (0%)

The worst 5 of 6 RSRZ outliers are listed below:

Mol	Chain	Res	Type	RSRZ
1	D	166	GLY	2.5
1	D	323	ILE	2.4
1	B	166	GLY	2.2
1	C	15	THR	2.2
1	D	232	ASN	2.0

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
3	LYO	C	402	11/11	0.81	0.16	109,111,114,115	0
5	GOL	A	404	6/6	0.81	0.12	92,95,101,101	0
5	GOL	D	403	6/6	0.81	0.12	86,93,95,97	0
4	SIN	D	402[A]	8/8	0.83	0.20	57,62,64,66	8
3	LYO	D	404	11/11	0.84	0.14	117,123,129,130	0
5	GOL	C	403	6/6	0.86	0.08	99,100,103,103	0
3	LYO	B	402[A]	11/11	0.88	0.18	75,78,81,82	11
4	SIN	B	403	8/8	0.90	0.13	101,107,112,113	0
3	LYO	A	402[A]	11/11	0.92	0.16	70,71,73,73	11
4	SIN	A	403	8/8	0.94	0.10	96,102,104,105	0
2	FE	C	401	1/1	0.96	0.12	89,89,89,89	0
2	FE	A	401	1/1	0.99	0.05	75,75,75,75	0
2	FE	D	401	1/1	0.99	0.03	84,84,84,84	0
2	FE	B	401	1/1	0.99	0.09	79,79,79,79	0

6.5 Other polymers [i](#)

There are no such residues in this entry.