



wwPDB X-ray Structure Validation Summary Report ⓘ

Jan 3, 2018 – 11:08 PM EST

PDB ID : 5WSA
Title : Pyruvate kinase (PYK) from Mycobacterium tuberculosis in complex with Oxalate and allosteric activator Glucose 6-Phosphate
Authors : Zhong, W.; Cai, Q.; El Sahili, A.; Lescar, J.; Dedon, P.C.
Deposited on : 2016-12-06
Resolution : 2.85 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

<http://wwpdb.org/validation/2016/XrayValidationReportHelp>

with specific help available everywhere you see the ⓘ symbol.

The following versions of software and data (see [references ⓘ](#)) were used in the production of this report:

MolProbity : 4.02b-467
Mogul : 1.7.2 (RC1), CSD as538be (2017)
Xtriage (Phenix) : 1.9-1692
EDS : rb-20030736
Percentile statistics : 20161228.v01 (using entries in the PDB archive December 28th 2016)
Refmac : 5.8.0135
CCP4 : 6.5.0
Ideal geometry (proteins) : Engh & Huber (2001)
Ideal geometry (DNA, RNA) : Parkinson et al. (1996)
Validation Pipeline (wwPDB-VP) : rb-20030736

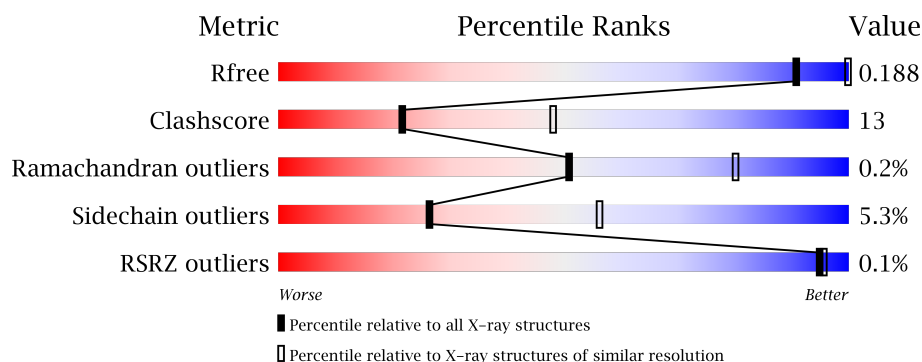
1 Overall quality at a glance

The following experimental techniques were used to determine the structure:

X-RAY DIFFRACTION





The reported resolution of this entry is 2.85 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}	100719	2469 (2.90-2.82)
Clashscore	112137	2749 (2.90-2.82)
Ramachandran outliers	110173	2687 (2.90-2.82)
Sidechain outliers	110143	2690 (2.90-2.82)
RSRZ outliers	101464	2487 (2.90-2.82)

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 on the lower bar indicate the fraction of residues that contain outliers for ≥ 3 , 2, 1 and 0 types of geometric quality criteria. 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	475	 75% 22% ..
1	B	475	 74% 23% ..
1	C	475	 72% 26% ..
1	D	475	 72% 26% ..

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 crite-

ria:

Mol	Type	Chain	Res	Chirality	Geometry	Clashes	Electron density
5	PO4	B	504	-	-	X	-
5	PO4	C	504	-	-	X	-

2 Entry composition

There are 6 unique types of molecules in this entry. The entry contains 14456 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.

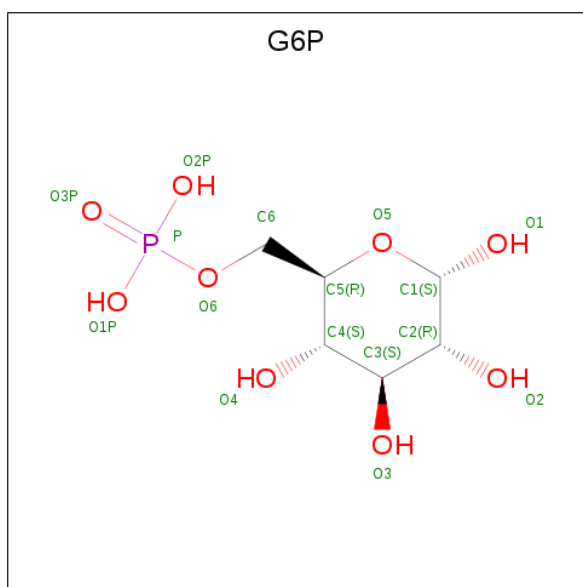
- Molecule 1 is a protein called Pyruvate kinase.

Mol	Chain	Residues	Atoms					ZeroOcc	AltConf	Trace
1	A	471	Total	C	N	O	S	0	0	0
			3543	2206	640	679	18			
1	B	471	Total	C	N	O	S	0	0	0
			3543	2206	640	679	18			
1	C	471	Total	C	N	O	S	0	0	0
			3543	2206	640	679	18			
1	D	471	Total	C	N	O	S	0	0	0
			3543	2206	640	679	18			

There are 12 discrepancies between the modelled and reference sequences:

Chain	Residue	Modelled	Actual	Comment	Reference
A	-2	GLY	-	expression tag	UNP P9WKE5
A	-1	GLY	-	expression tag	UNP P9WKE5
A	0	HIS	-	expression tag	UNP P9WKE5
B	-2	GLY	-	expression tag	UNP P9WKE5
B	-1	GLY	-	expression tag	UNP P9WKE5
B	0	HIS	-	expression tag	UNP P9WKE5
C	-2	GLY	-	expression tag	UNP P9WKE5
C	-1	GLY	-	expression tag	UNP P9WKE5
C	0	HIS	-	expression tag	UNP P9WKE5
D	-2	GLY	-	expression tag	UNP P9WKE5
D	-1	GLY	-	expression tag	UNP P9WKE5
D	0	HIS	-	expression tag	UNP P9WKE5

- Molecule 2 is ALPHA-D-GLUCOSE-6-PHOSPHATE (three-letter code: G6P) (formula: C₆H₁₃O₉P).

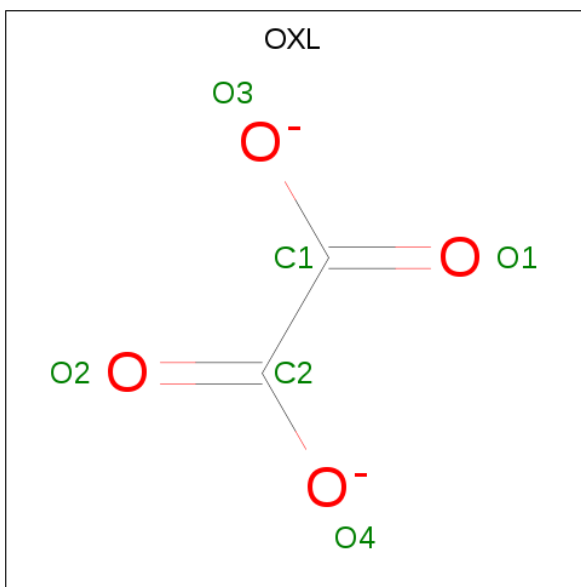


Mol	Chain	Residues	Atoms				ZeroOcc	AltConf
2	A	1	Total	C	O	P	0	0
			16	6	9	1		
2	B	1	Total	C	O	P	0	0
			16	6	9	1		
2	C	1	Total	C	O	P	0	0
			16	6	9	1		
2	D	1	Total	C	O	P	0	0
			16	6	9	1		

- Molecule 3 is MAGNESIUM ION (three-letter code: MG) (formula: Mg).

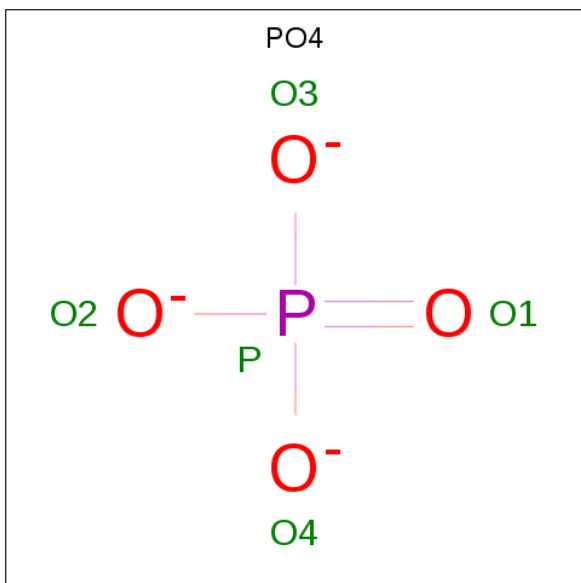
Mol	Chain	Residues	Atoms		ZeroOcc	AltConf
3	B	1	Total	Mg	0	0
			1	1		
3	A	1	Total	Mg	0	0
			1	1		
3	D	1	Total	Mg	0	0
			1	1		
3	C	1	Total	Mg	0	0
			1	1		

- Molecule 4 is OXALATE ION (three-letter code: OXL) (formula: C₂O₄).



Mol	Chain	Residues	Atoms			ZeroOcc	AltConf
4	A	1	Total	C	O	0	0
			6	2	4		
4	B	1	Total	C	O	0	0
			6	2	4		
4	C	1	Total	C	O	0	0
			6	2	4		
4	D	1	Total	C	O	0	0
			6	2	4		

- Molecule 5 is PHOSPHATE ION (three-letter code: PO4) (formula: O₄P).



Mol	Chain	Residues	Atoms	ZeroOcc	AltConf
5	A	1	Total O P 5 4 1	0	0
5	B	1	Total O P 5 4 1	0	0
5	C	1	Total O P 5 4 1	0	0
5	D	1	Total O P 5 4 1	0	0

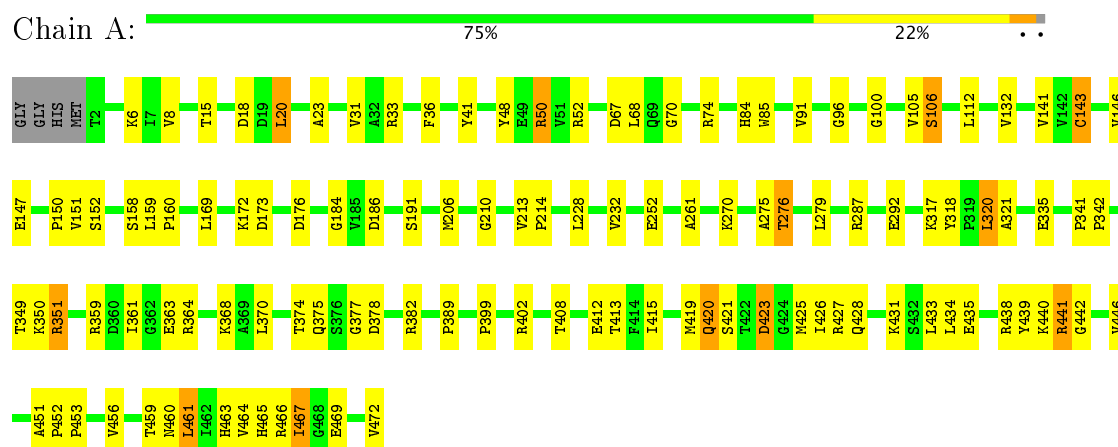
- Molecule 6 is water.

Mol	Chain	Residues	Atoms	ZeroOcc	AltConf
6	A	46	Total O 46 46	0	0
6	B	43	Total O 43 43	0	0
6	C	49	Total O 49 49	0	0
6	D	34	Total O 34 34	0	0

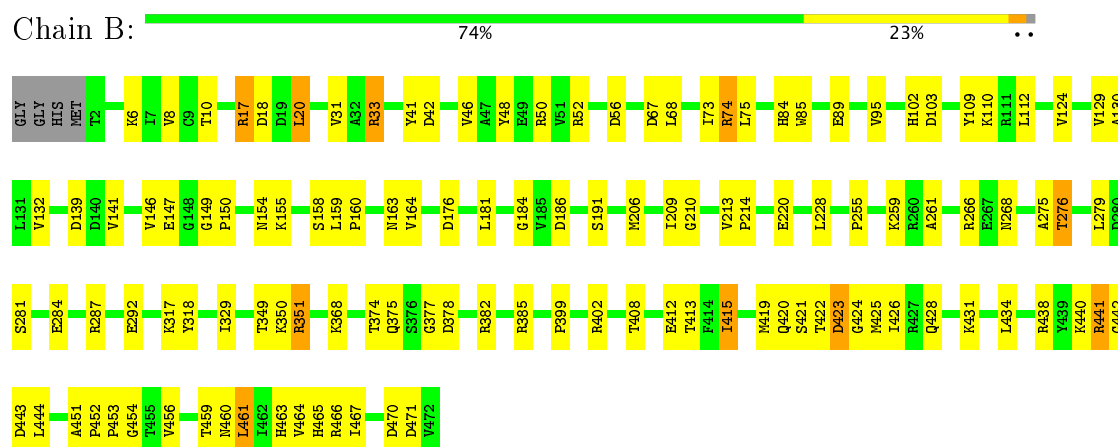
3 Residue-property plots

These plots are drawn for all protein, RNA and DNA 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.

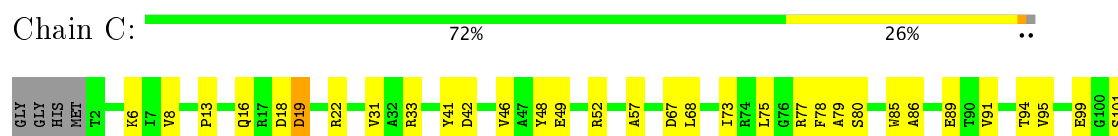
• Molecule 1: Pyruvate kinase

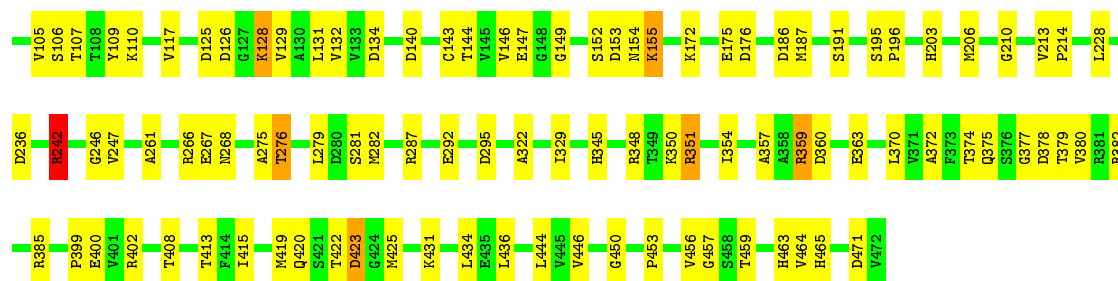


• Molecule 1: Pyruvate kinase



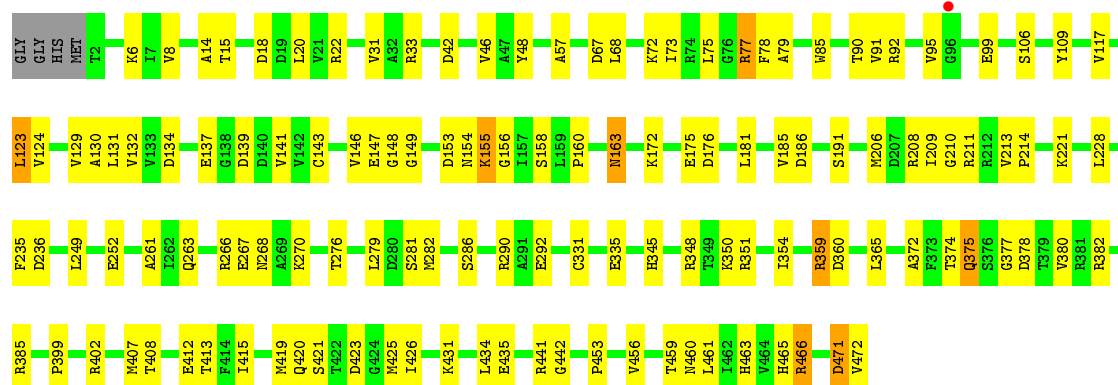
• Molecule 1: Pyruvate kinase





• Molecule 1: Pyruvate kinase

Chain D: 72% 26%



4 Data and refinement statistics

Property	Value	Source
Space group	P 31	Depositor
Cell constants a, b, c, α , β , γ	125.42Å 125.42Å 144.19Å 90.00° 90.00° 120.00°	Depositor
Resolution (Å)	62.71 – 2.85 54.31 – 2.85	Depositor EDS
% Data completeness (in resolution range)	100.0 (62.71-2.85) 100.0 (54.31-2.85)	Depositor EDS
R_{merge}	(Not available)	Depositor
R_{sym}	(Not available)	Depositor
$\langle I/\sigma(I) \rangle$ ¹	3.34 (at 2.86Å)	Xtriage
Refinement program	REFMAC 5.8.0158	Depositor
R, R_{free}	0.151 , 0.195 0.144 , 0.188	Depositor DCC
R_{free} test set	3001 reflections (5.34%)	DCC
Wilson B-factor (Å ²)	40.8	Xtriage
Anisotropy	0.830	Xtriage
Bulk solvent k_{sol} (e/Å ³), B_{sol} (Å ²)	0.37 , 18.4	EDS
L-test for twinning ²	$\langle L \rangle = 0.42$, $\langle L^2 \rangle = 0.25$	Xtriage
Estimated twinning fraction	0.467 for -h,-k,l 0.467 for h,-h-k,-l 0.478 for -k,-h,-l	Xtriage
Reported twinning fraction	0.278 for H, K, L 0.277 for -K, -H, -L 0.218 for K, H, -L 0.227 for -h,-k,l	Depositor
Outliers	0 of 59195 reflections	Xtriage
F_o, F_c correlation	0.95	EDS
Total number of atoms	14456	wwPDB-VP
Average B, all atoms (Å ²)	43.0	wwPDB-VP

Xtriage's analysis on translational NCS is as follows: *The largest off-origin peak in the Patterson function is 3.70% 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: OXL, MG, PO4, G6P

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	0.74	0/3593	0.73	0/4881
1	B	0.73	0/3593	0.72	0/4881
1	C	0.70	0/3593	0.71	1/4881 (0.0%)
1	D	0.70	0/3593	0.70	0/4881
All	All	0.72	0/14372	0.71	1/19524 (0.0%)

There are no bond length outliers.

All (1) bond angle outliers are listed below:

Mol	Chain	Res	Type	Atoms	Z	Observed(°)	Ideal(°)
1	C	242	ARG	NE-CZ-NH1	6.54	123.57	120.30

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	3543	0	3608	86	0
1	B	3543	0	3608	103	1
1	C	3543	0	3607	108	1
1	D	3543	0	3608	106	1
2	A	16	0	11	1	0
2	B	16	0	11	2	0

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Mol	Chain	Non-H	H(model)	H(added)	Clashes	Symm-Clashes
2	C	16	0	11	4	0
2	D	16	0	11	5	0
3	A	1	0	0	0	0
3	B	1	0	0	0	0
3	C	1	0	0	0	0
3	D	1	0	0	0	0
4	A	6	0	0	0	0
4	B	6	0	0	0	0
4	C	6	0	0	1	0
4	D	6	0	0	0	0
5	A	5	0	0	1	0
5	B	5	0	0	2	0
5	C	5	0	0	2	0
5	D	5	0	0	1	0
6	A	46	0	0	3	0
6	B	43	0	0	4	0
6	C	49	0	0	5	0
6	D	34	0	0	4	1
All	All	14456	0	14475	384	2

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 13.

The worst 5 of 384 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:D:77:ARG:HA	1:D:153:ASP:OD1	1.33	1.22
1:D:77:ARG:CA	1:D:153:ASP:OD1	1.96	1.12
1:A:441:ARG:HA	1:A:467:ILE:CG2	1.79	1.12
1:A:375:GLN:HG2	1:A:456:VAL:HG23	1.28	1.10
1:B:375:GLN:HG2	1:B:456:VAL:HG12	1.32	1.06

All (2) 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:C:49:GLU:OE1	6:D:602:HOH:O[2_655]	2.12	0.08
1:B:56:ASP:OD2	1:D:134:ASP:OD1[3_564]	2.16	0.04

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	469/475 (99%)	453 (97%)	15 (3%)	1 (0%)	51	80
1	B	469/475 (99%)	457 (97%)	11 (2%)	1 (0%)	51	80
1	C	469/475 (99%)	457 (97%)	11 (2%)	1 (0%)	51	80
1	D	469/475 (99%)	456 (97%)	12 (3%)	1 (0%)	51	80
All	All	1876/1900 (99%)	1823 (97%)	49 (3%)	4 (0%)	51	80

All (4) Ramachandran outliers are listed below:

Mol	Chain	Res	Type
1	A	276	THR
1	B	276	THR
1	C	276	THR
1	D	276	THR

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	379/381 (100%)	358 (94%)	21 (6%)	25	55
1	B	379/381 (100%)	357 (94%)	22 (6%)	23	52
1	C	379/381 (100%)	362 (96%)	17 (4%)	32	63
1	D	379/381 (100%)	359 (95%)	20 (5%)	26	56
All	All	1516/1524 (100%)	1436 (95%)	80 (5%)	26	56

5 of 80 residues with a non-rotameric sidechain are listed below:

Mol	Chain	Res	Type
1	B	420	GLN
1	C	19	ASP
1	D	412	GLU
1	B	423	ASP
1	B	438	ARG

Some sidechains can be flipped to improve hydrogen bonding and reduce clashes. 5 of 10 such sidechains are listed below:

Mol	Chain	Res	Type
1	C	404	GLN
1	C	463	HIS
1	D	268	ASN
1	B	463	HIS
1	D	38	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 carbohydrates in this entry.

5.6 Ligand geometry [i](#)

Of 16 ligands modelled in this entry, 4 are monoatomic - leaving 12 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
2	G6P	A	501	-	16,16,16	0.71	0	24,24,24	0.83	0
4	OXL	A	503	3	0,5,5	0.00	-	0,6,6	0.00	-
5	PO4	A	504	-	4,4,4	0.62	0	6,6,6	0.75	0
2	G6P	B	501	-	16,16,16	0.53	0	24,24,24	1.39	2 (8%)
4	OXL	B	503	3	0,5,5	0.00	-	0,6,6	0.00	-
5	PO4	B	504	-	4,4,4	0.66	0	6,6,6	0.52	0
2	G6P	C	501	-	16,16,16	0.66	0	24,24,24	1.03	1 (4%)
4	OXL	C	503	3	0,5,5	0.00	-	0,6,6	0.00	-
5	PO4	C	504	-	4,4,4	0.70	0	6,6,6	0.81	0
2	G6P	D	501	-	16,16,16	0.53	0	24,24,24	0.88	0
4	OXL	D	503	3	0,5,5	0.00	-	0,6,6	0.00	-
5	PO4	D	504	-	4,4,4	1.17	0	6,6,6	0.43	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
2	G6P	A	501	-	-	0/6/26/26	0/1/1/1
4	OXL	A	503	3	-	0/0/4/4	0/0/0/0
5	PO4	A	504	-	-	0/0/0/0	0/0/0/0
2	G6P	B	501	-	-	0/6/26/26	0/1/1/1
4	OXL	B	503	3	-	0/0/4/4	0/0/0/0
5	PO4	B	504	-	-	0/0/0/0	0/0/0/0
2	G6P	C	501	-	-	0/6/26/26	0/1/1/1
4	OXL	C	503	3	-	0/0/4/4	0/0/0/0
5	PO4	C	504	-	-	0/0/0/0	0/0/0/0
2	G6P	D	501	-	-	0/6/26/26	0/1/1/1
4	OXL	D	503	3	-	0/0/4/4	0/0/0/0
5	PO4	D	504	-	-	0/0/0/0	0/0/0/0

There are no bond length outliers.

All (3) bond angle outliers are listed below:

Mol	Chain	Res	Type	Atoms	Z	Observed(°)	Ideal(°)
2	C	501	G6P	O5-C5-C6	2.61	111.85	106.64
2	B	501	G6P	C1-O5-C5	2.90	118.62	113.39
2	B	501	G6P	O5-C1-C2	4.50	117.50	110.04

There are no chirality outliers.

There are no torsion outliers.

There are no ring outliers.

9 monomers are involved in 19 short contacts:

Mol	Chain	Res	Type	Clashes	Symm-Clashes
2	A	501	G6P	1	0
5	A	504	PO4	1	0
2	B	501	G6P	2	0
5	B	504	PO4	2	0
2	C	501	G6P	4	0
4	C	503	OXL	1	0
5	C	504	PO4	2	0
2	D	501	G6P	5	0
5	D	504	PO4	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(Å²)	Q<0.9	
1	A	471/475 (99%)	-0.28	0	100	100	25, 40, 57, 77	0
1	B	471/475 (99%)	-0.31	0	100	100	26, 40, 57, 75	0
1	C	471/475 (99%)	-0.21	0	100	100	27, 44, 63, 83	0
1	D	471/475 (99%)	-0.19	1 (0%)	94	95	26, 44, 66, 96	0
All	All	1884/1900 (99%)	-0.25	1 (0%)	95	95	25, 42, 62, 96	0

All (1) RSRZ outliers are listed below:

Mol	Chain	Res	Type	RSRZ
1	D	96	GLY	2.2

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 carbohydrates 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. LLDF column lists the quality of electron density of the group with respect to its neighbouring residues in protein, DNA or RNA chains. 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	LLDF	B-factors(\AA^2)	Q<0.9
4	OXL	C	503	6/6	0.94	0.17	0.88	21,33,44,47	0
4	OXL	D	503	6/6	0.96	0.15	0.41	15,24,38,46	0
2	G6P	A	501	16/16	0.99	0.17	0.18	24,36,41,44	0
4	OXL	A	503	6/6	0.83	0.17	-0.18	24,26,28,28	0
4	OXL	B	503	6/6	0.90	0.15	-0.23	17,19,24,26	0
5	PO4	A	504	5/5	0.99	0.15	-0.49	29,33,40,42	0
5	PO4	D	504	5/5	0.98	0.15	-0.62	30,31,34,39	0
2	G6P	B	501	16/16	0.98	0.14	-0.63	22,31,34,35	0
2	G6P	D	501	16/16	0.99	0.14	-0.68	20,37,41,45	0
5	PO4	B	504	5/5	0.99	0.15	-0.81	40,41,43,44	0
5	PO4	C	504	5/5	0.98	0.12	-1.10	33,33,37,39	0
2	G6P	C	501	16/16	0.98	0.13	-1.29	24,29,31,41	0
3	MG	C	502	1/1	0.99	0.09	-	24,24,24,24	0
3	MG	D	502	1/1	0.98	0.09	-	33,33,33,33	0
3	MG	A	502	1/1	0.96	0.10	-	27,27,27,27	0
3	MG	B	502	1/1	0.99	0.10	-	25,25,25,25	0

6.5 Other polymers [i](#)

There are no such residues in this entry.