W O R L D W I D E
wwPDB
PROTEIN DATA BANK

wwPDB X-ray Structure Validation Summary Report (i)

Apr 21, 2024 – 01:49 pm BST

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PDB ID	:	2YJG
Title	:	Structure of the lactate racemase apoprotein from Thermoanaerobacterium thermosaccharolyticum
Authors	:	Declercq, J.P.; Desguin, B.; Soumillion, P.; Hols, P.
Deposited on	:	2011-05-19
Resolution	:	1.80 Å(reported)

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 1.80 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.
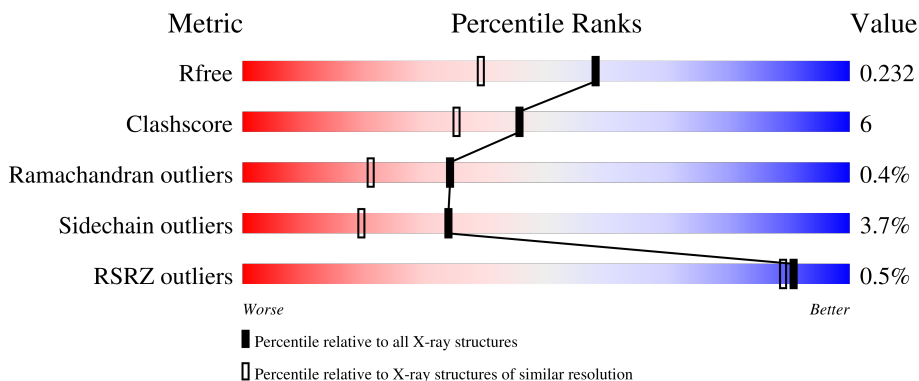
Metric	Whole archive (#Entries)	Similar resolution (#Entries, resolution range(Å))
R_{free}	130704	5950 (1.80-1.80)
Clashscore	141614	6793 (1.80-1.80)
Ramachandran outliers	138981	6697 (1.80-1.80)
Sidechain outliers	138945	6696 (1.80-1.80)
RSRZ outliers	127900	5850 (1.80-1.80)

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 <=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	436	82% 13% · ·
1	B	436	81% 14% · ·

2 Entry composition ⓘ

There are 5 unique types of molecules in this entry. The entry contains 7076 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 LACTATE RACEMASE APOPROTEIN.

Mol	Chain	Residues	Atoms					ZeroOcc	AltConf	Trace
1	A	418	Total	C	N	O	S	0	0	0
			3234	2044	563	613	14			
1	B	417	Total	C	N	O	S	0	0	0
			3225	2038	561	612	14			

There are 20 discrepancies between the modelled and reference sequences:

Chain	Residue	Modelled	Actual	Comment	Reference
A	427	ALA	-	expression tag	UNP D9TQ02
A	428	SER	-	expression tag	UNP D9TQ02
A	429	TRP	-	expression tag	UNP D9TQ02
A	430	SER	-	expression tag	UNP D9TQ02
A	431	HIS	-	expression tag	UNP D9TQ02
A	432	PRO	-	expression tag	UNP D9TQ02
A	433	GLN	-	expression tag	UNP D9TQ02
A	434	PHE	-	expression tag	UNP D9TQ02
A	435	GLU	-	expression tag	UNP D9TQ02
A	436	LYS	-	expression tag	UNP D9TQ02
B	427	ALA	-	expression tag	UNP D9TQ02
B	428	SER	-	expression tag	UNP D9TQ02
B	429	TRP	-	expression tag	UNP D9TQ02
B	430	SER	-	expression tag	UNP D9TQ02
B	431	HIS	-	expression tag	UNP D9TQ02
B	432	PRO	-	expression tag	UNP D9TQ02
B	433	GLN	-	expression tag	UNP D9TQ02
B	434	PHE	-	expression tag	UNP D9TQ02
B	435	GLU	-	expression tag	UNP D9TQ02
B	436	LYS	-	expression tag	UNP D9TQ02

- Molecule 2 is MAGNESIUM ION (three-letter code: MG) (formula: Mg).

Mol	Chain	Residues	Atoms		ZeroOcc	AltConf
2	A	1	Total 1	Mg 1	0	0

- Molecule 3 is SULFATE ION (three-letter code: SO4) (formula: O_4S).

Mol	Chain	Residues	Atoms			ZeroOcc	AltConf
3	A	1	Total 5	O 4	S 1	0	0
3	A	1	Total 5	O 4	S 1	0	0
3	B	1	Total 5	O 4	S 1	0	0
3	B	1	Total 5	O 4	S 1	0	0
3	B	1	Total 5	O 4	S 1	0	0

- Molecule 4 is 1,2-ETHANEDIOL (three-letter code: EDO) (formula: $C_2H_6O_2$).

EDO

O2

OH

C1

C2

HO

O1

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

- Molecule 5 is water.

Mol	Chain	Residues	Atoms		ZeroOcc	AltConf
5	A	330	Total 330	O 330	0	0
5	B	257	Total 257	O 257	0	0

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: LACTATE RACEMASE APOPROTEIN

Chain A:

Chain B:
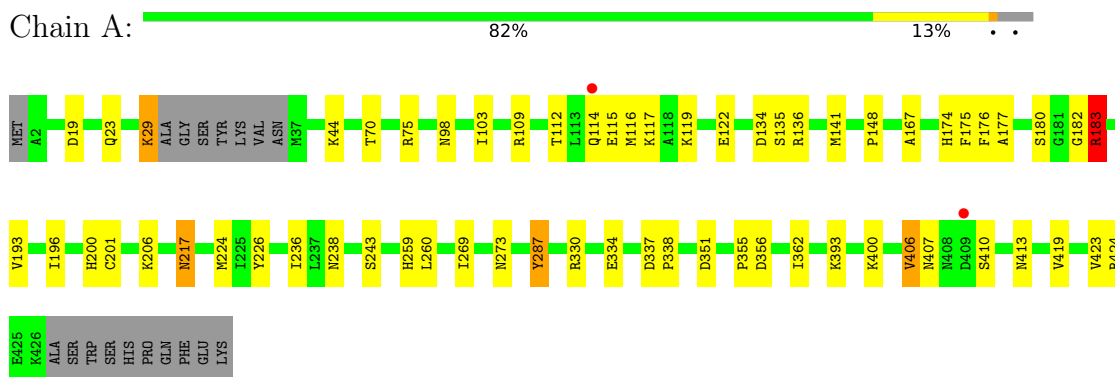
- Molecule 1: LACTATE RACEMASE APOPROTEIN
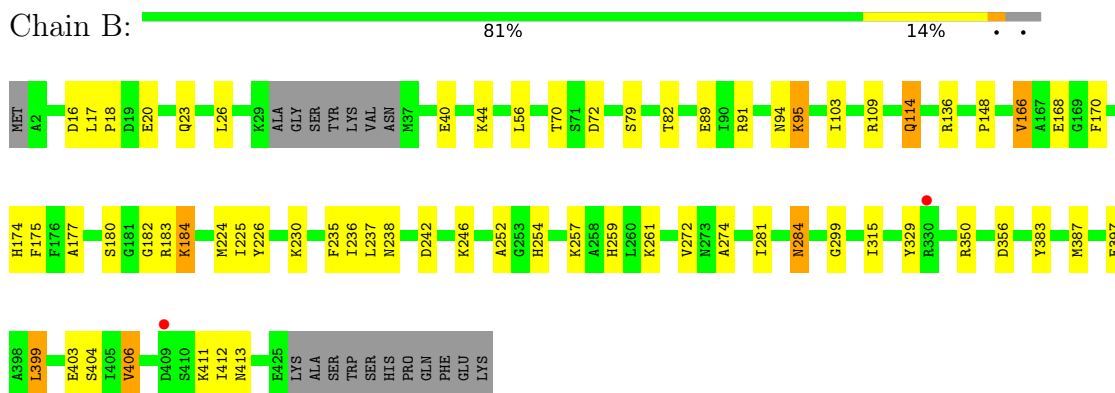
4 Data and refinement statistics (i)

Property	Value	Source
Space group	P 21 21 2	Depositor
Cell constants a, b, c, α, β, γ	78.41Å 223.25Å 46.14Å 90.00° 90.00° 90.00°	Depositor
Resolution (Å)	114.96 – 1.80 45.19 – 1.80	Depositor EDS
% Data completeness (in resolution range)	97.1 (114.96-1.80) 97.1 (45.19-1.80)	Depositor EDS
R_{merge}	0.06	Depositor
R_{sym}	(Not available)	Depositor
$< I/\sigma(I) >$ [1]	2.12 (at 1.81Å)	Xtriage
Refinement program	REFMAC 5.5.0109	Depositor
R, R_{free}	0.182 , 0.229 0.186 , 0.232	Depositor DCC
R_{free} test set	3721 reflections (5.04%)	wwPDB-VP
Wilson B-factor (Å^2)	21.6	Xtriage
Anisotropy	0.061	Xtriage
Bulk solvent k_{sol}(e/Å^3), B_{sol}(Å^2)	0.37 , 49.8	EDS
L-test for twinning[2]	$< |L| > = 0.42, < L^2 > = 0.25$	Xtriage
Estimated twinning fraction	No twinning to report.	Xtriage
F_o,F_c correlation	0.95	EDS
Total number of atoms	7076	wwPDB-VP
Average B, all atoms (Å^2)	24.0	wwPDB-VP

Xtriage's analysis on translational NCS is as follows: *The largest off-origin peak in the Patterson function is 3.63% of the height of the origin peak. No significant pseudotranslation is detected.*

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[1]Intensities estimated from amplitudes.
[2]Theoretical values of $< |L| >$, $< L^2 >$ 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: EDO, SO4, MG

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	0.97	4/3287 (0.1%)	0.90	6/4433 (0.1%)
1	B	0.84	1/3278 (0.0%)	0.81	3/4422 (0.1%)
All	All	0.91	5/6565 (0.1%)	0.86	9/8855 (0.1%)

All (5) bond length outliers are listed below:

Mol	Chain	Res	Type	Atoms	Z	Observed(Å)	Ideal(Å)
1	A	201	CYS	CB-SG	-5.83	1.72	1.81
1	A	362	ILE	CB-CG2	5.46	1.69	1.52
1	B	166	VAL	CB-CG1	-5.37	1.41	1.52
1	A	419	VAL	CB-CG1	-5.10	1.42	1.52
1	A	423	VAL	CB-CG1	5.06	1.63	1.52

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

Mol	Chain	Res	Type	Atoms	Z	Observed(^{o})	Ideal(^{o})
1	B	136	ARG	NE-CZ-NH2	-5.93	117.33	120.30
1	A	116	MET	CG-SD-CE	-5.84	90.86	100.20
1	A	19	ASP	CB-CG-OD1	5.63	123.36	118.30
1	A	75	ARG	NE-CZ-NH1	5.62	123.11	120.30
1	A	183	ARG	NE-CZ-NH1	5.52	123.06	120.30

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	3234	0	3285	45	0
1	B	3225	0	3272	39	0
2	A	1	0	0	0	0
3	A	10	0	0	0	0
3	B	15	0	0	0	0
4	A	4	0	6	0	0
5	A	330	0	0	12	0
5	B	257	0	0	2	0
All	All	7076	0	6563	84	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 6.

The worst 5 of 84 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:26:LEU:HB3	1:B:272:VAL:HG11	1.28	1.09
1:A:217:ASN:HB2	5:A:2207:HOH:O	1.72	0.90
1:A:182:GLY:H	1:A:238:ASN:HD21	1.24	0.85
1:B:174:HIS:HD2	1:B:177:ALA:H	1.24	0.83
1:A:70:THR:CG2	1:A:103:ILE:HD13	2.09	0.83

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	414/436 (95%)	402 (97%)	11 (3%)	1 (0%)	47	33
1	B	413/436 (95%)	404 (98%)	7 (2%)	2 (0%)	29	15

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Mol	Chain	Analysed	Favoured	Allowed	Outliers	Percentiles
All	All	827/872 (95%)	806 (98%)	18 (2%)	3 (0%)	34 21

All (3) Ramachandran outliers are listed below:

Mol	Chain	Res	Type
1	B	406	VAL
1	A	406	VAL
1	B	94	ASN

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	352/367 (96%)	342 (97%)	10 (3%)	43 30
1	B	351/367 (96%)	335 (95%)	16 (5%)	27 13
All	All	703/734 (96%)	677 (96%)	26 (4%)	34 19

5 of 26 residues with a non-rotameric sidechain are listed below:

Mol	Chain	Res	Type
1	B	170	PHE
1	B	184	LYS
1	B	404	SER
1	B	183	ARG
1	B	246	LYS

Sometimes sidechains can be flipped to improve hydrogen bonding and reduce clashes. 5 of 20 such sidechains are listed below:

Mol	Chain	Res	Type
1	B	238	ASN
1	B	284	ASN
1	B	413	ASN
1	B	369	ASN
1	A	259	HIS

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 monosaccharides in this entry.

5.6 Ligand geometry ⓘ

Of 7 ligands modelled in this entry, 1 is monoatomic - leaving 6 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	SO4	A	1428	-	4,4,4	0.30	0	6,6,6	0.67	0
3	SO4	A	1429	-	4,4,4	0.42	0	6,6,6	0.78	0
3	SO4	B	1427	-	4,4,4	0.36	0	6,6,6	0.53	0
3	SO4	B	1428	-	4,4,4	0.22	0	6,6,6	0.56	0
3	SO4	B	1426	-	4,4,4	0.15	0	6,6,6	0.29	0
4	EDO	A	1430	-	3,3,3	0.36	0	2,2,2	0.38	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
4	EDO	A	1430	-	-	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
4	A	1430	EDO	O1-C1-C2-O2

There are no ring outliers.

No monomer is involved in short contacts.

5.7   Other polymers ⓘ

There are no such residues in this entry.

5.8   Polymer linkage issues ⓘ

There are no chain breaks in this entry.

6 Fit of model and data ⓘ

6.1 Protein, DNA and RNA chains ⓘ

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	418/436 (95%)	-0.42	2 (0%)	91	89	9, 19, 33, 49	0
1	B	417/436 (95%)	-0.26	2 (0%)	91	89	14, 23, 43, 53	0
All	All	835/872 (95%)	-0.34	4 (0%)	91	89	9, 21, 40, 53	0

All (4) RSRZ outliers are listed below:

Mol	Chain	Res	Type	RSRZ
1	B	409	ASP	2.2
1	A	409	ASP	2.1
1	A	114	GLN	2.1
1	B	330	ARG	2.0

6.2 Non-standard residues in protein, DNA, RNA chains ⓘ

There are no non-standard protein/DNA/RNA residues in this entry.

6.3 Carbohydrates ⓘ

There are no monosaccharides in this entry.

6.4 Ligands ⓘ

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(Å²)	Q<0.9
4	EDO	A	1430	4/4	0.88	0.16	40,41,41,42	0

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Mol	Type	Chain	Res	Atoms	RSCC	RSR	B-factors(Å^2)	Q<0.9
3	SO4	A	1429	5/5	0.93	0.12	32,39,42,42	0
3	SO4	B	1426	5/5	0.95	0.14	58,58,60,60	0
3	SO4	B	1427	5/5	0.98	0.07	32,34,35,36	0
3	SO4	B	1428	5/5	0.98	0.07	42,44,46,47	0
3	SO4	A	1428	5/5	0.98	0.10	32,36,37,40	0
2	MG	A	1427	1/1	1.00	0.03	15,15,15,15	0

6.5 Other polymers ⓘ

There are no such residues in this entry.