



Full wwPDB X-ray Structure Validation Report ⓘ

Mar 9, 2026 – 01:42 AM UTC

PDB ID : 1XFC / pdb_00001xfg
Title : The 1.9 Å crystal structure of alanine racemase from Mycobacterium tuberculosis contains a conserved entryway into the active site
Authors : LeMagueres, P.; Im, H.; Ebalunode, J.; Strych, U.; Benedik, M.J.; Briggs, J.M.; Kohn, H.; Krause, K.L.
Deposited on : 2004-09-14
Resolution : 1.90 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)	:	NOT EXECUTED
EDS	:	NOT EXECUTED
Percentile statistics	:	20250101.v01 (using entries in the PDB archive January 1st 2025)
Ideal geometry (proteins)	:	Engh & Huber (2001)
Ideal geometry (DNA, RNA)	:	Parkinson et al. (1996)
Validation Pipeline (wwPDB-VP)	:	2.49

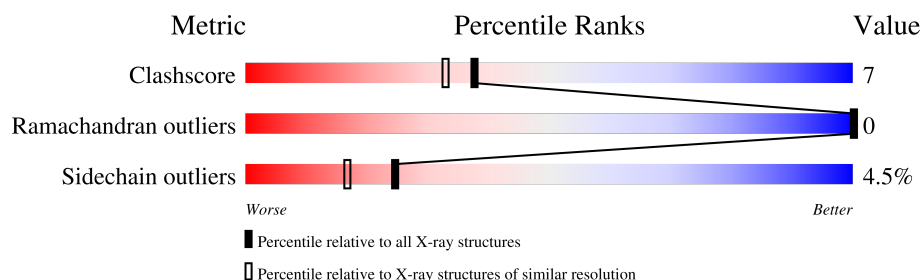
1 Overall quality at a glance

The following experimental techniques were used to determine the structure:

X-RAY DIFFRACTION

The reported resolution of this entry is 1.90 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	8410 (1.90-1.90)
Ramachandran outliers	187476	8333 (1.90-1.90)
Sidechain outliers	187428	8333 (1.90-1.90)

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 $\leq 5\%$.

Note EDS was not executed.

Mol	Chain	Length	Quality of chain
1	A	384	
1	B	384	

2 Entry composition [i](#)

There are 3 unique types of molecules in this entry. The entry contains 5740 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 Alanine racemase.

Mol	Chain	Residues	Atoms					ZeroOcc	AltConf	Trace
1	A	366	Total	C	N	O	S	0	0	0
			2713	1701	496	502	14			
1	B	356	Total	C	N	O	S	0	0	0
			2647	1659	484	490	14			

- Molecule 2 is PYRIDOXAL-5'-PHOSPHATE (CCD ID: PLP) (formula: $C_8H_{10}NO_6P$).



Mol	Chain	Residues	Atoms					ZeroOcc	AltConf
2	A	1	Total	C	N	O	P	0	0
			15	8	1	5	1		
2	B	1	Total	C	N	O	P	0	0
			15	8	1	5	1		

- Molecule 3 is water.

Mol	Chain	Residues	Atoms		ZeroOcc	AltConf
3	A	162	Total 162	O 162	0	0
3	B	188	Total 188	O 188	0	0

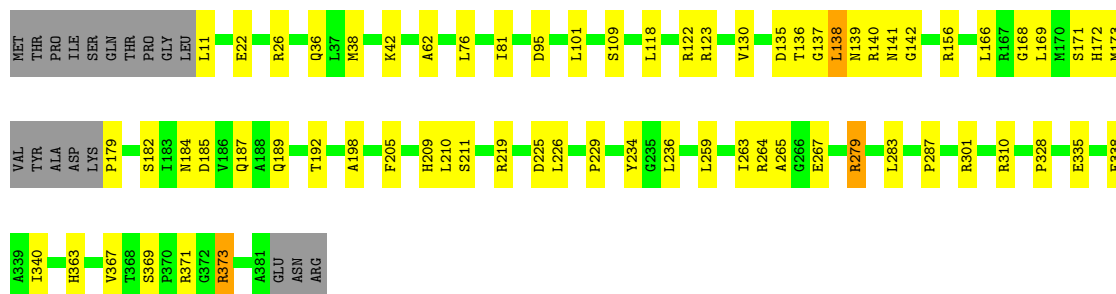
3 Residue-property plots

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. 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. 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.

Note EDS was not executed.

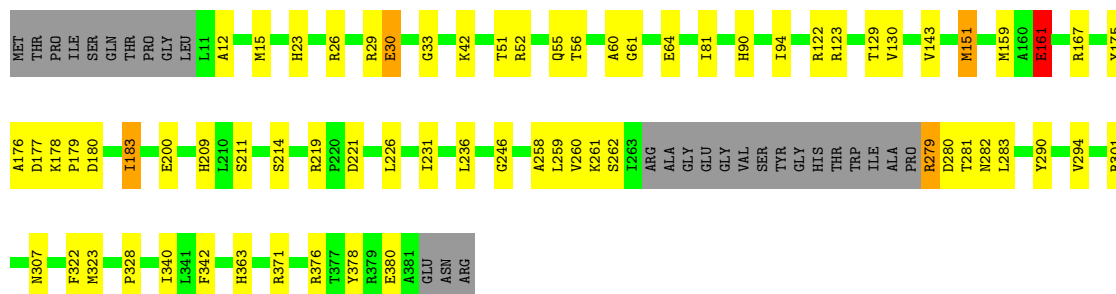
• Molecule 1: Alanine racemase

Chain A: 



• Molecule 1: Alanine racemase

Chain B: 



4 Data and refinement statistics

Xtriage (Phenix) and EDS were not executed - this section is therefore incomplete.

Property	Value	Source
Space group	P 41 21 2	Depositor
Cell constants a, b, c, α , β , γ	164.78Å 164.78Å 57.88Å 90.00° 90.00° 90.00°	Depositor
Resolution (Å)	30.00 – 1.90	Depositor
% Data completeness (in resolution range)	(Not available) (30.00-1.90)	Depositor
R_{merge}	0.06	Depositor
R_{sym}	(Not available)	Depositor
Refinement program	SHELXL-97	Depositor
R, R_{free}	0.204 , 0.254	Depositor
Estimated twinning fraction	No twinning to report.	Xtriage
Total number of atoms	5740	wwPDB-VP
Average B, all atoms (Å ²)	28.0	wwPDB-VP

5 Model quality

5.1 Standard geometry

Bond lengths and bond angles in the following residue types are not validated in this section: PLP

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	0.43	0/2762	1.38	16/3758 (0.4%)
1	B	0.42	0/2692	1.40	15/3661 (0.4%)
All	All	0.43	0/5454	1.39	31/7419 (0.4%)

There are no bond length outliers.

All (31) bond angle outliers are listed below:

Mol	Chain	Res	Type	Atoms	Z	Observed(°)	Ideal(°)
1	A	141	ASN	CA-CB-CG	9.14	121.74	112.60
1	B	211	SER	N-CA-C	8.51	123.58	109.46
1	A	310	ARG	CD-NE-CZ	8.37	136.12	124.40
1	A	156	ARG	CD-NE-CZ	7.80	135.32	124.40
1	A	211	SER	N-CA-C	7.09	120.10	109.25
1	A	138	LEU	CA-C-N	6.85	133.81	123.05
1	A	138	LEU	C-N-CA	6.85	133.81	123.05
1	A	137	GLY	CA-C-N	6.80	130.24	120.79
1	A	137	GLY	C-N-CA	6.80	130.24	120.79
1	B	322	PHE	CA-CB-CG	6.43	120.23	113.80
1	B	342	PHE	CA-CB-CG	6.42	120.22	113.80
1	A	168	GLY	N-CA-C	6.14	120.11	110.96
1	B	90	HIS	O-C-N	5.84	127.83	121.23
1	B	33	GLY	CA-C-N	-5.77	110.33	121.58
1	B	33	GLY	C-N-CA	-5.77	110.33	121.58
1	A	184	ASN	CA-CB-CG	-5.77	106.83	112.60
1	A	168	GLY	O-C-N	-5.72	118.25	123.57
1	A	209	HIS	CA-CB-CG	5.66	119.46	113.80
1	A	62	ALA	CA-C-O	-5.63	115.58	121.55
1	A	198	ALA	O-C-N	5.43	127.66	122.07
1	B	130	VAL	N-CA-C	5.42	117.13	108.89
1	B	129	THR	CA-C-N	-5.39	114.59	122.68

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Mol	Chain	Res	Type	Atoms	Z	Observed(°)	Ideal(°)
1	B	129	THR	C-N-CA	-5.39	114.59	122.68
1	B	161	GLU	CA-C-N	5.30	130.09	122.40
1	B	161	GLU	C-N-CA	5.30	130.09	122.40
1	B	12	ALA	CA-C-N	-5.24	112.68	121.75
1	B	12	ALA	C-N-CA	-5.24	112.68	121.75
1	B	56	THR	CA-C-O	5.24	126.10	120.55
1	A	130	VAL	N-CA-C	5.10	116.87	108.97
1	B	258	ALA	CA-C-O	5.09	125.22	119.27
1	A	234	TYR	CA-CB-CG	-5.06	104.80	113.90

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	2713	0	2725	40	0
1	B	2647	0	2672	39	0
2	A	15	0	6	1	0
2	B	15	0	6	1	0
3	A	162	0	0	1	0
3	B	188	0	0	4	0
All	All	5740	0	5409	76	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 7.

All (76) 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:280:ASP:O	1:B:328:PRO:HB3	1.83	0.78
1:A:136:THR:OG1	1:A:138:LEU:HD21	1.84	0.77
1:A:138:LEU:HD22	1:A:172:HIS:O	1.85	0.77
1:B:209:HIS:HB3	1:B:226:LEU:HB3	1.69	0.73
1:A:118:LEU:O	1:A:122:ARG:HD3	1.91	0.71

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Atom-1	Atom-2	Interatomic distance (Å)	Clash overlap (Å)
1:B:143:VAL:HG21	1:B:151:MET:HE3	1.72	0.70
1:A:22:GLU:O	1:A:26:ARG:HG3	1.92	0.70
1:A:135:ASP:HA	1:A:138:LEU:HD12	1.74	0.68
1:B:307:ASN:HB2	3:B:439:HOH:O	1.92	0.68
1:B:15:MET:HE3	3:B:526:HOH:O	1.94	0.66
1:B:179:PRO:HG3	1:B:214:SER:OG	1.97	0.65
1:A:136:THR:H	1:A:138:LEU:HD11	1.62	0.64
1:B:279:ARG:NH2	1:B:328:PRO:HD3	2.13	0.64
1:A:179:PRO:O	1:A:219:ARG:HD3	1.99	0.62
1:A:264:ARG:O	1:A:267:GLU:HG3	2.02	0.60
1:B:51:THR:O	1:B:55:GLN:HG3	2.01	0.60
1:B:177:ASP:O	1:B:178:LYS:HD3	2.01	0.60
1:A:265:ALA:HB2	1:A:279:ARG:HA	1.85	0.58
1:A:301:ARG:HH11	1:A:301:ARG:HG3	1.68	0.58
1:A:36:GLN:HB2	1:A:226:LEU:CD1	2.34	0.58
1:A:166:LEU:HD13	1:A:205:PHE:CE1	2.39	0.57
1:A:136:THR:H	1:A:138:LEU:CD1	2.18	0.56
1:B:200:GLU:HG3	3:B:527:HOH:O	2.04	0.56
1:B:209:HIS:CG	1:B:226:LEU:HD22	2.40	0.56
1:B:161:GLU:O	1:B:161:GLU:HG3	2.07	0.55
1:A:189:GLN:O	1:A:192:THR:HB	2.07	0.55
1:B:29:ARG:CZ	1:B:61:GLY:HA3	2.37	0.54
1:A:210:LEU:HG	1:A:210:LEU:O	2.08	0.53
1:A:338:GLU:OE2	1:A:340:ILE:HD11	2.09	0.52
1:A:182:SER:HA	1:A:185:ASP:OD1	2.10	0.52
1:A:140:ARG:O	1:B:261:LYS:HE3	2.09	0.52
1:B:176:ALA:O	1:B:214:SER:HB2	2.09	0.52
1:A:279:ARG:NH2	1:A:328:PRO:HD3	2.25	0.52
1:A:369:SER:O	1:A:371:ARG:HG2	2.10	0.52
1:A:135:ASP:HA	1:A:138:LEU:CD1	2.40	0.51
1:A:263:ILE:HD13	1:A:283:LEU:HD11	1.92	0.51
1:B:26:ARG:O	1:B:30:GLU:OE2	2.29	0.50
1:B:179:PRO:O	1:B:219:ARG:HD3	2.11	0.50
1:A:109:SER:HB2	1:A:142:GLY:HA2	1.94	0.48
1:A:36:GLN:HB2	1:A:226:LEU:HD13	1.95	0.48
1:A:139:ASN:O	1:B:261:LYS:HD3	2.14	0.48
1:A:173:MET:HA	1:A:187:GLN:OE1	2.14	0.47
1:B:23:HIS:HE1	1:B:246:GLY:O	1.98	0.47
1:A:371:ARG:HD3	1:B:371:ARG:CD	2.44	0.47
1:B:94:ILE:O	1:B:94:ILE:HG23	2.14	0.47
1:A:38:MET:O	1:A:229:PRO:HD2	2.15	0.46

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Atom-1	Atom-2	Interatomic distance (Å)	Clash overlap (Å)
1:B:42:LYS:NZ	2:B:390:PLP:O3	2.50	0.45
1:A:287:PRO:O	1:A:373:ARG:NH2	2.50	0.45
1:B:29:ARG:NH1	1:B:60:ALA:O	2.50	0.45
1:B:159:MET:HE3	1:B:159:MET:HB3	1.94	0.44
1:B:64:GLU:OE2	1:B:167:ARG:NH2	2.50	0.44
1:B:376:ARG:HD3	1:B:378:TYR:OH	2.18	0.44
1:B:52:ARG:NH2	1:B:380:GLU:OE2	2.50	0.44
1:B:175:TYR:CE1	1:B:183:ILE:HG21	2.53	0.43
1:B:177:ASP:C	1:B:179:PRO:HD3	2.43	0.43
1:A:95:ASP:OD1	1:A:123:ARG:NH2	2.50	0.43
1:A:138:LEU:HD11	1:A:171:SER:OG	2.18	0.43
1:A:225:ASP:C	1:A:226:LEU:HD22	2.43	0.43
1:B:259:LEU:HD12	1:B:260:VAL:N	2.34	0.43
1:A:42:LYS:NZ	2:A:390:PLP:O3	2.51	0.43
1:B:231:ILE:HG13	1:B:236:LEU:HB2	2.00	0.43
1:A:11:LEU:HD23	1:A:11:LEU:HA	1.80	0.43
1:B:151:MET:HB2	1:B:151:MET:HE2	1.58	0.42
1:B:177:ASP:OD1	1:B:177:ASP:N	2.51	0.42
1:A:236:LEU:HD11	1:A:367:VAL:HG11	2.01	0.42
1:B:143:VAL:CG2	1:B:151:MET:HE3	2.47	0.42
1:A:259:LEU:HA	1:A:335:GLU:CG	2.50	0.42
1:B:281:THR:OG1	1:B:282:ASN:N	2.53	0.42
1:A:169:LEU:HD13	1:A:205:PHE:CE2	2.56	0.41
1:B:290:TYR:HA	1:B:294:VAL:O	2.21	0.41
1:B:283:LEU:HB3	1:B:323:MET:CE	2.51	0.41
1:A:138:LEU:HD13	3:A:476:HOH:O	2.20	0.41
1:B:15:MET:HE1	3:B:528:HOH:O	2.20	0.41
1:B:221:ASP:OD1	1:B:221:ASP:N	2.54	0.41
1:A:76:LEU:HD22	1:A:81:ILE:HG13	2.03	0.40
1:A:101:LEU:HD23	1:A:101:LEU:HA	1.89	0.40

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	362/384 (94%)	351 (97%)	11 (3%)	0	100	100
1	B	352/384 (92%)	339 (96%)	13 (4%)	0	100	100
All	All	714/768 (93%)	690 (97%)	24 (3%)	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	85/292 (29%)	82 (96%)	3 (4%)	32	24
1	B	270/292 (92%)	257 (95%)	13 (5%)	23	15
All	All	355/584 (61%)	339 (96%)	16 (4%)	24	17

All (16) residues with a non-rotameric sidechain are listed below:

Mol	Chain	Res	Type
1	A	279	ARG
1	A	363	HIS
1	A	373	ARG
1	B	30	GLU
1	B	81	ILE
1	B	122	ARG
1	B	123	ARG
1	B	151	MET
1	B	161	GLU
1	B	180	ASP
1	B	183	ILE
1	B	262	SER
1	B	279	ARG
1	B	301	ARG
1	B	340	ILE

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Mol	Chain	Res	Type
1	B	363	HIS

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

Mol	Chain	Res	Type
1	A	307	ASN
1	A	321	GLN
1	B	31	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](#)

2 ligands are modelled in this entry.

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	PLP	A	390	1	15,15,16	1.55	3 (20%)	21,22,23	0.95	0
2	PLP	B	390	1	15,15,16	1.40	2 (13%)	21,22,23	1.00	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	PLP	A	390	1	-	1/6/6/8	0/1/1/1
2	PLP	B	390	1	-	2/6/6/8	0/1/1/1

All (5) bond length outliers are listed below:

Mol	Chain	Res	Type	Atoms	Z	Observed(Å)	Ideal(Å)
2	A	390	PLP	C3-C2	-4.14	1.36	1.41
2	B	390	PLP	C3-C2	-3.45	1.37	1.41
2	B	390	PLP	P-O2P	-2.24	1.46	1.54
2	A	390	PLP	P-O2P	-2.02	1.47	1.54
2	A	390	PLP	C2A-C2	2.01	1.53	1.50

There are no bond angle outliers.

There are no chirality outliers.

All (3) torsion outliers are listed below:

Mol	Chain	Res	Type	Atoms
2	B	390	PLP	C6-C5-C5A-O4P
2	B	390	PLP	C4-C5-C5A-O4P
2	A	390	PLP	C4-C5-C5A-O4P

There are no ring outliers.

2 monomers are involved in 2 short contacts:

Mol	Chain	Res	Type	Clashes	Symm-Clashes
2	A	390	PLP	1	0
2	B	390	PLP	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

6.1 Protein, DNA and RNA chains

EDS was not executed - this section is therefore empty.

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

EDS was not executed - this section is therefore empty.

6.3 Carbohydrates

EDS was not executed - this section is therefore empty.

6.4 Ligands

EDS was not executed - this section is therefore empty.

6.5 Other polymers

EDS was not executed - this section is therefore empty.