



Full wwPDB X-ray Structure Validation Report ⓘ

Mar 5, 2026 – 10:10 AM UTC

PDB ID : 1RCQ / pdb_00001rcq
Title : The 1.45 Å crystal structure of alanine racemase from a pathogenic bacterium, *Pseudomonas aeruginosa*, contains both internal and external aldimine forms
Authors : Le Magueres, P.; Im, H.; Dvorak, A.; Strych, U.; Benedik, M.; Krause, K.L.
Deposited on : 2003-11-04
Resolution : 1.45 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

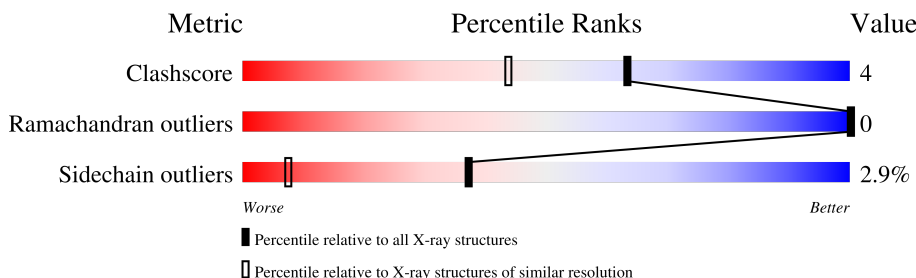
1 Overall quality at a glance

The following experimental techniques were used to determine the structure:

X-RAY DIFFRACTION

The reported resolution of this entry is 1.45 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	1795 (1.46-1.46)
Ramachandran outliers	187476	1776 (1.46-1.46)
Sidechain outliers	187428	1776 (1.46-1.46)

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	357	

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
3	DLY	A	359	-	-	X	-

2 Entry composition [i](#)

There are 4 unique types of molecules in this entry. The entry contains 3099 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 catabolic alanine racemase DadX.

Mol	Chain	Residues	Atoms					ZeroOcc	AltConf	Trace
			Total	C	N	O	S			
1	A	357	2753	1741	504	493	15	0	0	0

There is a discrepancy between the modelled and reference sequences:

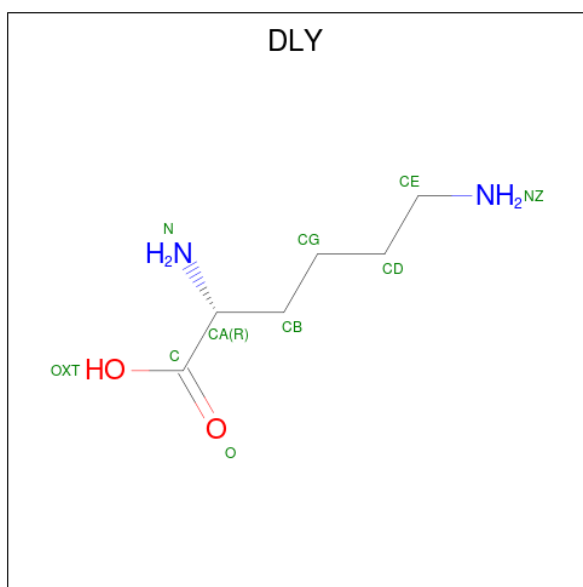
Chain	Residue	Modelled	Actual	Comment	Reference
A	122	KCX	LYS	modified residue	UNP Q9HTQ2

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



Mol	Chain	Residues	Atoms					ZeroOcc	AltConf
			Total	C	N	O	P		
2	A	1	30	16	2	10	2	0	1

- Molecule 3 is D-LYSINE (CCD ID: DLY) (formula: $C_6H_{14}N_2O_2$).



Mol	Chain	Residues	Atoms				ZeroOcc	AltConf
3	A	1	Total	C	N	O	0	0
			10	6	2	2		

- Molecule 4 is water.

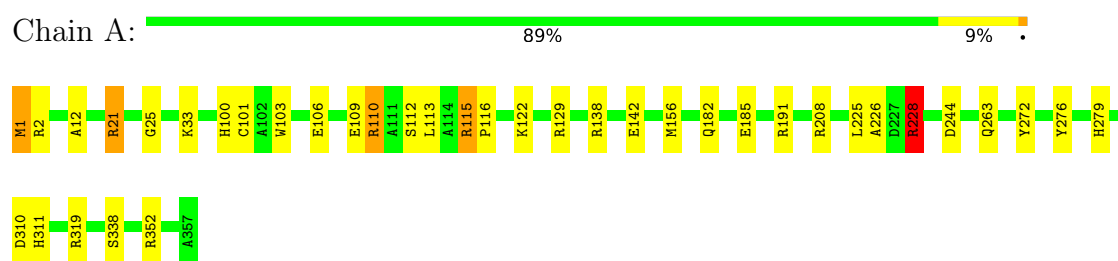
Mol	Chain	Residues	Atoms		ZeroOcc	AltConf
4	A	306	Total	O	0	0
			306	306		

3 Residue-property plots [i](#)

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: catabolic alanine racemase DadX



4 Data and refinement statistics

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

Property	Value	Source
Space group	C 2 2 21	Depositor
Cell constants a, b, c, α , β , γ	72.68Å 76.13Å 136.27Å 90.00° 90.00° 90.00°	Depositor
Resolution (Å)	30.00 – 1.45	Depositor
% Data completeness (in resolution range)	(Not available) (30.00-1.45)	Depositor
R_{merge}	0.03	Depositor
R_{sym}	(Not available)	Depositor
Refinement program	SHELXL-97	Depositor
R, R_{free}	0.149 , 0.206	Depositor
Estimated twinning fraction	No twinning to report.	Xtriage
Total number of atoms	3099	wwPDB-VP
Average B, all atoms (Å ²)	22.0	wwPDB-VP

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: KCX, PLP, DLY

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	0.62	0/2803	1.42	23/3800 (0.6%)

There are no bond length outliers.

All (23) bond angle outliers are listed below:

Mol	Chain	Res	Type	Atoms	Z	Observed(°)	Ideal(°)
1	A	115	ARG	CD-NE-CZ	8.03	135.64	124.40
1	A	21	ARG	CD-NE-CZ	-7.65	113.69	124.40
1	A	263	GLN	CA-C-N	6.84	132.62	123.05
1	A	263	GLN	C-N-CA	6.84	132.62	123.05
1	A	226	ALA	O-C-N	6.76	130.12	122.22
1	A	191	ARG	N-CA-C	6.58	119.43	108.96
1	A	338	SER	CA-CB-OG	6.16	123.43	111.10
1	A	208	ARG	NE-CZ-NH1	6.10	127.60	121.50
1	A	244	ASP	CA-CB-CG	6.09	118.69	112.60
1	A	109	GLU	CA-C-N	-5.84	112.90	122.54
1	A	109	GLU	C-N-CA	-5.84	112.90	122.54
1	A	225	LEU	CA-C-N	5.82	128.66	120.28
1	A	225	LEU	C-N-CA	5.82	128.66	120.28
1	A	352	ARG	NE-CZ-NH2	5.81	124.43	119.20
1	A	25	GLY	CA-C-N	5.63	132.84	122.92
1	A	25	GLY	C-N-CA	5.63	132.84	122.92
1	A	116	PRO	CA-C-N	5.57	130.33	122.09
1	A	116	PRO	C-N-CA	5.57	130.33	122.09
1	A	113	LEU	CA-C-O	-5.36	114.57	120.36
1	A	310	ASP	N-CA-CB	5.34	117.93	110.56
1	A	21	ARG	NE-CZ-NH1	-5.20	116.30	121.50
1	A	228	ARG	CD-NE-CZ	5.19	131.67	124.40
1	A	12	ALA	O-C-N	5.12	127.55	122.12

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	2753	0	2747	18	0
2	A	30	0	12	3	0
3	A	10	0	11	7	0
4	A	306	0	0	6	0
All	All	3099	0	2770	21	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 4.

All (21) 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)
2:A:358[A]:PLP:C4A	3:A:359:DLY:NZ	2.14	1.09
1:A:101:CYS:HG	1:A:103:TRP:CD1	2.04	0.75
1:A:129:ARG:HH22	3:A:359:DLY:H	1.41	0.69
1:A:319:ARG:HG3	4:A:826:HOH:O	1.99	0.62
1:A:228:ARG:HH11	1:A:228:ARG:HG2	1.70	0.56
1:A:272:TYR:HA	1:A:276:TYR:O	2.07	0.55
1:A:106:GLU:O	1:A:110:ARG:HG3	2.08	0.53
1:A:33:LYS:NZ	3:A:359:DLY:HA	2.24	0.53
1:A:311:HIS:HD2	4:A:591:HOH:O	1.92	0.52
1:A:33:LYS:NZ	2:A:358[B]:PLP:C4	2.50	0.50
1:A:100:HIS:HE1	4:A:589:HOH:O	1.94	0.50
1:A:129:ARG:HH12	3:A:359:DLY:CA	2.24	0.49
2:A:358[B]:PLP:O3	3:A:359:DLY:N	2.48	0.47
1:A:138:ARG:O	1:A:142:GLU:HG3	2.15	0.46
1:A:279:HIS:HD2	4:A:505:HOH:O	1.99	0.46
1:A:103:TRP:HZ2	4:A:725:HOH:O	2.01	0.44
1:A:110:ARG:HB2	1:A:110:ARG:CZ	2.50	0.42
1:A:21:ARG:NH2	4:A:714:HOH:O	2.49	0.41
3:A:359:DLY:NZ	3:A:359:DLY:N	2.69	0.41

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Atom-1	Atom-2	Interatomic distance (Å)	Clash overlap (Å)
1:A:1:MET:HG3	1:A:2:ARG:N	2.35	0.40
1:A:129:ARG:NH2	3:A:359:DLY:H	2.13	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	A	354/357 (99%)	347 (98%)	7 (2%)	0	100	100

There are no Ramachandran outliers to report.

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	A	276/276 (100%)	268 (97%)	8 (3%)	37	7

All (8) residues with a non-rotameric sidechain are listed below:

Mol	Chain	Res	Type
1	A	1	MET
1	A	110	ARG
1	A	112	SER
1	A	115	ARG

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Mol	Chain	Res	Type
1	A	156	MET
1	A	182	GLN
1	A	185	GLU
1	A	228	ARG

Sometimes sidechains can be flipped to improve hydrogen bonding and reduce clashes. All (6) such sidechains are listed below:

Mol	Chain	Res	Type
1	A	100	HIS
1	A	158	HIS
1	A	279	HIS
1	A	311	HIS
1	A	313	GLN
1	A	326	ASN

5.3.3 RNA ⓘ

There are no RNA molecules in this entry.

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

1 non-standard protein/DNA/RNA residue is 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
1	KCX	A	122	1	10,11,12	1.55	2 (20%)	6,12,14	1.85	1 (16%)

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
1	KCX	A	122	1	-	1/9/10/12	-

All (2) bond length outliers are listed below:

Mol	Chain	Res	Type	Atoms	Z	Observed(Å)	Ideal(Å)
1	A	122	KCX	OQ1-CX	3.93	1.28	1.21
1	A	122	KCX	CX-NZ	-2.36	1.30	1.35

All (1) bond angle outliers are listed below:

Mol	Chain	Res	Type	Atoms	Z	Observed(°)	Ideal(°)
1	A	122	KCX	OQ1-CX-NZ	-4.11	118.68	124.92

There are no chirality outliers.

All (1) torsion outliers are listed below:

Mol	Chain	Res	Type	Atoms
1	A	122	KCX	CG-CD-CE-NZ

There are no ring outliers.

No monomer is involved in short contacts.

5.5 Carbohydrates [i](#)

There are no oligosaccharides in this entry.

5.6 Ligand geometry [i](#)

3 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	$\# Z > 2$
3	DLY	A	359	2	8,9,9	1.44	2 (25%)	7,10,10	2.14	1 (14%)

Mol	Type	Chain	Res	Link	Bond lengths			Bond angles		
					Counts	RMSZ	# Z > 2	Counts	RMSZ	# Z > 2
2	PLP	A	358[B]	1,3	15,15,16	1.18	1 (6%)	21,22,23	1.15	2 (9%)
2	PLP	A	358[A]	1	15,15,16	1.21	1 (6%)	21,22,23	1.31	1 (4%)

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	DLY	A	359	2	-	7/9/9/9	-
2	PLP	A	358[B]	1,3	-	0/6/6/8	0/1/1/1
2	PLP	A	358[A]	1	-	0/6/6/8	0/1/1/1

All (4) bond length outliers are listed below:

Mol	Chain	Res	Type	Atoms	Z	Observed(Å)	Ideal(Å)
2	A	358[A]	PLP	C3-C2	-2.75	1.38	1.41
3	A	359	DLY	CB-CA	-2.56	1.47	1.53
2	A	358[B]	PLP	C3-C2	-2.56	1.38	1.41
3	A	359	DLY	CG-CB	-2.29	1.42	1.52

All (4) bond angle outliers are listed below:

Mol	Chain	Res	Type	Atoms	Z	Observed(°)	Ideal(°)
3	A	359	DLY	CG-CB-CA	5.14	129.82	113.22
2	A	358[A]	PLP	C4A-C4-C5	-3.32	117.52	120.94
2	A	358[B]	PLP	C4A-C4-C5	-2.35	118.51	120.94
2	A	358[B]	PLP	C2A-C2-N1	2.15	121.70	117.64

There are no chirality outliers.

All (7) torsion outliers are listed below:

Mol	Chain	Res	Type	Atoms
3	A	359	DLY	C-CA-CB-CG
3	A	359	DLY	CA-CB-CG-CD
3	A	359	DLY	OXT-C-CA-CB
3	A	359	DLY	O-C-CA-CB
3	A	359	DLY	OXT-C-CA-N
3	A	359	DLY	O-C-CA-N
3	A	359	DLY	CG-CD-CE-NZ

There are no ring outliers.

3 monomers are involved in 8 short contacts:

Mol	Chain	Res	Type	Clashes	Symm-Clashes
3	A	359	DLY	7	0
2	A	358[B]	PLP	2	0
2	A	358[A]	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.