



wwPDB X-ray Structure Validation Summary Report ⓘ

Mar 5, 2026 – 06:57 PM UTC

PDB ID : 1XPY / pdb_00001xpy
Title : Structural Basis for Catalytic Racemization and Substrate Specificity of an N-Acylamino Acid Racemase Homologue from *Deinococcus radiodurans*
Authors : Wang, W.-C.; Chiu, W.-C.; Hsu, S.-K.; Wu, C.-L.; Chen, C.-Y.; Liu, J.-S.; Hsu, W.-H.
Deposited on : 2004-10-10
Resolution : 2.30 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)
Xtrriage (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

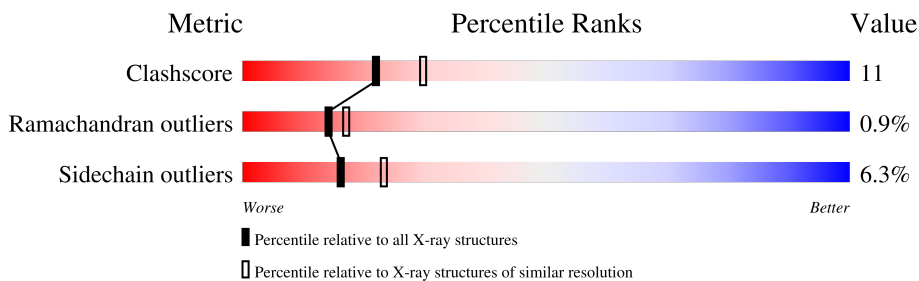
1 Overall quality at a glance

The following experimental techniques were used to determine the structure:

X-RAY DIFFRACTION

The reported resolution of this entry is 2.30 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	6919 (2.30-2.30)
Ramachandran outliers	187476	6854 (2.30-2.30)
Sidechain outliers	187428	6854 (2.30-2.30)

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	375	
1	B	375	
1	C	375	
1	D	375	

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	NLQ	C	3376	-	X	X	-

2 Entry composition [i](#)

There are 4 unique types of molecules in this entry. The entry contains 12108 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 N-acylamino acid racemase.

Mol	Chain	Residues	Atoms					ZeroOcc	AltConf	Trace
			Total	C	N	O	S			
1	A	360	2766	1733	507	516	10	0	0	0
1	B	360	2766	1733	507	516	10	0	0	0
1	C	370	2852	1790	521	531	10	0	0	0
1	D	370	2852	1790	521	531	10	0	0	0

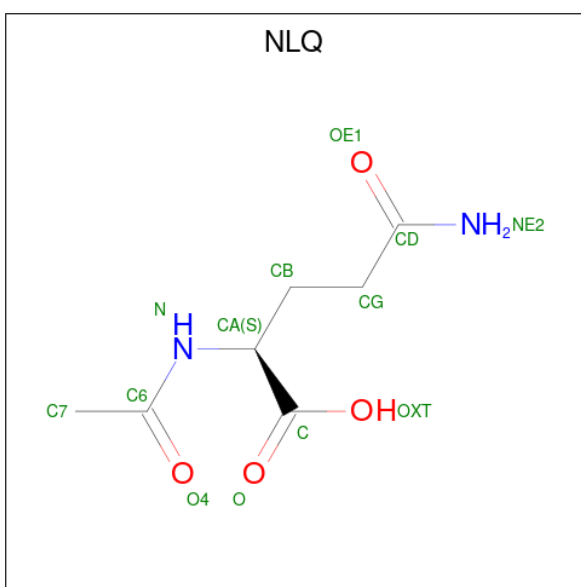
There are 20 discrepancies between the modelled and reference sequences:

Chain	Residue	Modelled	Actual	Comment	Reference
A	94	SER	ALA	SEE REMARK 999	UNP Q9RYA6
A	148	ASP	GLY	SEE REMARK 999	UNP Q9RYA6
A	158	ARG	LYS	SEE REMARK 999	UNP Q9RYA6
A	252	SER	ALA	SEE REMARK 999	UNP Q9RYA6
A	315	SER	PRO	SEE REMARK 999	UNP Q9RYA6
B	94	SER	ALA	SEE REMARK 999	UNP Q9RYA6
B	148	ASP	GLY	SEE REMARK 999	UNP Q9RYA6
B	158	ARG	LYS	SEE REMARK 999	UNP Q9RYA6
B	252	SER	ALA	SEE REMARK 999	UNP Q9RYA6
B	315	SER	PRO	SEE REMARK 999	UNP Q9RYA6
C	94	SER	ALA	SEE REMARK 999	UNP Q9RYA6
C	148	ASP	GLY	SEE REMARK 999	UNP Q9RYA6
C	158	ARG	LYS	SEE REMARK 999	UNP Q9RYA6
C	252	SER	ALA	SEE REMARK 999	UNP Q9RYA6
C	315	SER	PRO	SEE REMARK 999	UNP Q9RYA6
D	94	SER	ALA	SEE REMARK 999	UNP Q9RYA6
D	148	ASP	GLY	SEE REMARK 999	UNP Q9RYA6
D	158	ARG	LYS	SEE REMARK 999	UNP Q9RYA6
D	252	SER	ALA	SEE REMARK 999	UNP Q9RYA6
D	315	SER	PRO	SEE REMARK 999	UNP Q9RYA6

- Molecule 2 is MAGNESIUM ION (CCD ID: MG) (formula: Mg).

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

- Molecule 3 is N 2 -ACETYL-L-GLUTAMINE (CCD ID: NLQ) (formula: C₇H₁₂N₂O₄).



Mol	Chain	Residues	Atoms	ZeroOcc	AltConf
3	C	1	Total C N O 13 7 2 4	0	0
3	D	1	Total C N O 13 7 2 4	0	0

- Molecule 4 is water.

Mol	Chain	Residues	Atoms	ZeroOcc	AltConf
4	A	234	Total O 234 234	0	0
4	B	229	Total O 229 229	0	0
4	C	191	Total O 191 191	0	0

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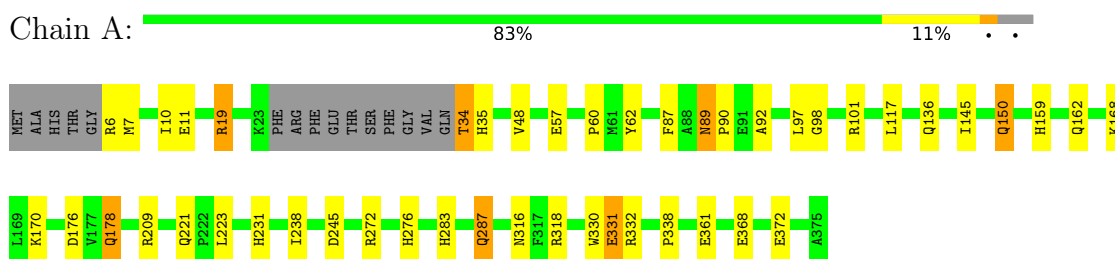
Mol	Chain	Residues	Atoms		ZeroOcc	AltConf
4	D	188	Total 188	O 188	0	0

3 Residue-property plots [i](#)

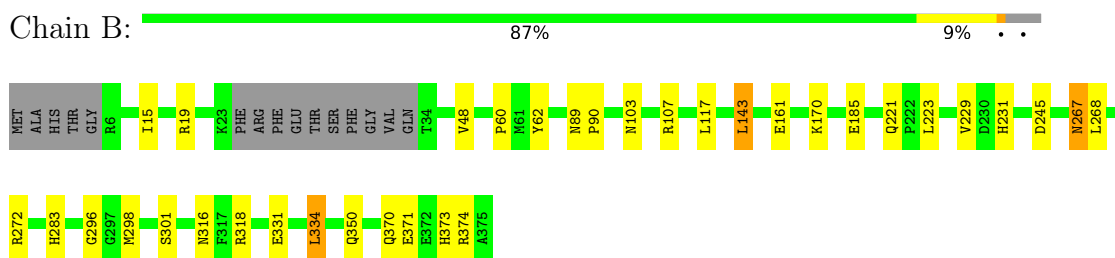
These plots are drawn for all protein, RNA, DNA and oligosaccharide chains in the entry. The first graphic for a chain summarises the proportions of the various outlier classes displayed in the second graphic. The second graphic shows the sequence view annotated by issues in geometry. Residues are color-coded 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.

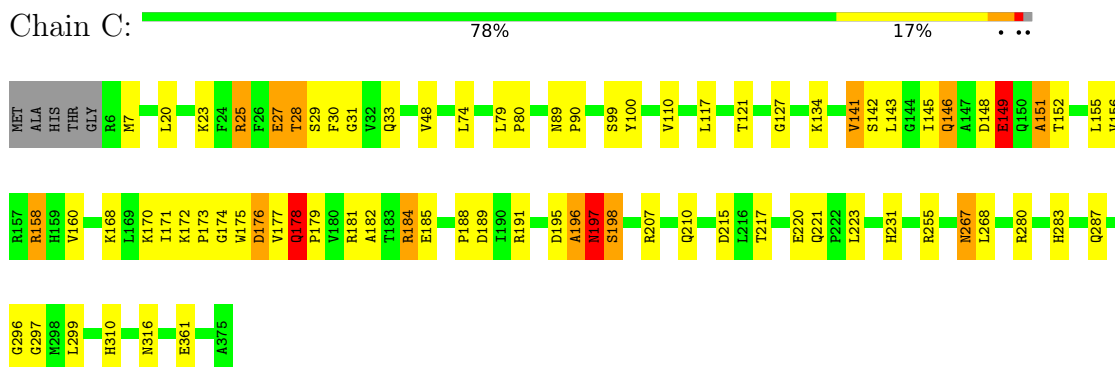
- Molecule 1: N-acylamino acid racemase



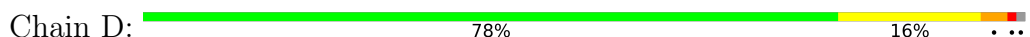
- Molecule 1: N-acylamino acid racemase

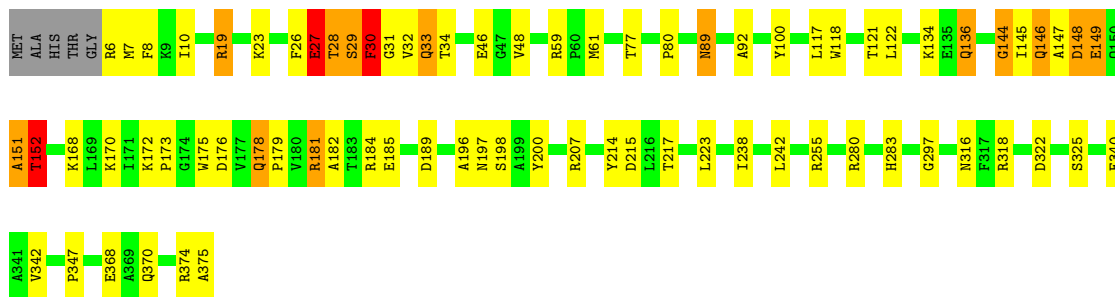


- Molecule 1: N-acylamino acid racemase



- Molecule 1: N-acylamino acid racemase





4 Data and refinement statistics

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

Property	Value	Source
Space group	P 4	Depositor
Cell constants a, b, c, α , β , γ	116.16Å 116.16Å 120.43Å 90.00° 90.00° 90.00°	Depositor
Resolution (Å)	30.00 – 2.30	Depositor
% Data completeness (in resolution range)	98.3 (30.00-2.30)	Depositor
R_{merge}	0.10	Depositor
R_{sym}	(Not available)	Depositor
Refinement program	REFMAC 5.1.24	Depositor
R, R_{free}	0.171 , 0.227	Depositor
Estimated twinning fraction	No twinning to report.	Xtrriage
Total number of atoms	12108	wwPDB-VP
Average B, all atoms (Å ²)	26.0	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: MG, NLQ

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	0.75	0/2817	0.89	2/3822 (0.1%)
1	B	0.76	1/2817 (0.0%)	0.89	0/3822
1	C	0.76	0/2907	0.93	2/3944 (0.1%)
1	D	0.76	0/2907	0.97	5/3944 (0.1%)
All	All	0.76	1/11448 (0.0%)	0.92	9/15532 (0.1%)

Chiral center outliers are detected by calculating the chiral volume of a chiral center and verifying if the center is modelled as a planar moiety or with the opposite hand. A planarity outlier is detected by checking planarity of atoms in a peptide group, atoms in a mainchain group or atoms of a sidechain that are expected to be planar.

Mol	Chain	#Chirality outliers	#Planarity outliers
1	A	0	1

All (1) bond length outliers are listed below:

Mol	Chain	Res	Type	Atoms	Z	Observed(Å)	Ideal(Å)
1	B	298	MET	SD-CE	5.88	1.94	1.79

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

Mol	Chain	Res	Type	Atoms	Z	Observed(°)	Ideal(°)
1	D	149	GLU	N-CA-C	7.24	118.86	110.97
1	D	148	ASP	N-CA-C	6.70	116.71	107.73
1	C	141	VAL	CB-CA-C	-6.08	100.19	110.71
1	D	27	GLU	N-CA-C	6.01	123.60	110.80
1	A	98	GLY	N-CA-C	5.95	121.21	114.67

There are no chirality outliers.

All (1) planarity outliers are listed below:

Mol	Chain	Res	Type	Group
1	A	97	LEU	Peptide

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	2766	0	2769	40	0
1	B	2766	0	2769	30	0
1	C	2852	0	2848	87	0
1	D	2852	0	2848	86	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	C	13	0	11	9	0
3	D	13	0	11	2	0
4	A	234	0	0	1	0
4	B	229	0	0	2	0
4	C	191	0	0	7	0
4	D	188	0	0	9	0
All	All	12108	0	11256	240	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 11.

The worst 5 of 240 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:145:ILE:HA	4:D:4391:HOH:O	1.44	1.16
1:D:149:GLU:HA	1:D:182:ALA:HB2	1.32	1.11
1:C:299:LEU:CD2	3:C:3376:NLQ:HE22	1.66	1.09
1:D:146:GLN:CD	1:D:152:THR:HA	1.88	0.98
1:D:149:GLU:HA	1:D:182:ALA:CB	1.94	0.98

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	356/375 (95%)	342 (96%)	14 (4%)	0	100	100
1	B	356/375 (95%)	342 (96%)	14 (4%)	0	100	100
1	C	368/375 (98%)	346 (94%)	16 (4%)	6 (2%)	7	7
1	D	368/375 (98%)	343 (93%)	18 (5%)	7 (2%)	6	5
All	All	1448/1500 (96%)	1373 (95%)	62 (4%)	13 (1%)	14	17

5 of 13 Ramachandran outliers are listed below:

Mol	Chain	Res	Type
1	C	196	ALA
1	D	29	SER
1	D	147	ALA
1	D	151	ALA
1	C	197	ASN

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	284/296 (96%)	266 (94%)	18 (6%)	16	23
1	B	284/296 (96%)	274 (96%)	10 (4%)	32	48
1	C	293/296 (99%)	270 (92%)	23 (8%)	11	16
1	D	293/296 (99%)	271 (92%)	22 (8%)	12	17
All	All	1154/1184 (98%)	1081 (94%)	73 (6%)	16	23

5 of 73 residues with a non-rotameric sidechain are listed below:

Mol	Chain	Res	Type
1	D	33	GLN
1	D	342	VAL
1	D	89	ASN
1	D	185	GLU
1	B	331	GLU

Sometimes sidechains can be flipped to improve hydrogen bonding and reduce clashes. 5 of 34 such sidechains are listed below:

Mol	Chain	Res	Type
1	D	33	GLN
1	D	89	ASN
1	D	197	ASN
1	B	35	HIS
1	A	316	ASN

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 6 ligands modelled in this entry, 4 are monoatomic - leaving 2 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	NLQ	D	4376	-	12,12,12	3.38	4 (33%)	15,15,15	3.36	4 (26%)
3	NLQ	C	3376	-	12,12,12	3.37	4 (33%)	15,15,15	3.56	8 (53%)

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	NLQ	D	4376	-	-	1/13/13/13	-
3	NLQ	C	3376	-	-	6/13/13/13	-

The worst 5 of 8 bond length outliers are listed below:

Mol	Chain	Res	Type	Atoms	Z	Observed(Å)	Ideal(Å)
3	C	3376	NLQ	O4-C6	8.21	1.41	1.23
3	D	4376	NLQ	O4-C6	8.15	1.41	1.23
3	C	3376	NLQ	OE1-CD	6.12	1.42	1.23
3	D	4376	NLQ	OE1-CD	5.77	1.41	1.23
3	D	4376	NLQ	CD-NE2	4.08	1.46	1.32

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

Mol	Chain	Res	Type	Atoms	Z	Observed(°)	Ideal(°)
3	C	3376	NLQ	O4-C6-N	-8.03	107.79	121.98
3	D	4376	NLQ	O4-C6-N	-7.74	108.31	121.98
3	D	4376	NLQ	O4-C6-C7	-7.69	108.36	122.05
3	C	3376	NLQ	O4-C6-C7	-6.63	110.25	122.05
3	D	4376	NLQ	OE1-CD-NE2	-4.69	110.01	122.53

There are no chirality outliers.

5 of 7 torsion outliers are listed below:

Mol	Chain	Res	Type	Atoms
3	C	3376	NLQ	C-CA-N-C6
3	C	3376	NLQ	N-CA-CB-CG
3	C	3376	NLQ	O4-C6-N-CA
3	D	4376	NLQ	O4-C6-N-CA
3	C	3376	NLQ	CA-CB-CG-CD

There are no ring outliers.

2 monomers are involved in 11 short contacts:

Mol	Chain	Res	Type	Clashes	Symm-Clashes
3	D	4376	NLQ	2	0
3	C	3376	NLQ	9	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.