



# Full wwPDB X-ray Structure Validation Report ⓘ

Nov 17, 2024 – 02:16 AM EST

PDB ID : 3OUT  
Title : Crystal structure of glutamate racemase from *Francisella tularensis* subsp. *tularensis* SCHU S4 in complex with D-glutamate.  
Authors : Filippova, E.V.; Wawrzak, Z.; Onopriyenko, O.; Kudriska, M.; Edwards, A.; Savchenko, A.; Anderson, F.W.; Center for Structural Genomics of Infectious Diseases (CSGID)  
Deposited on : 2010-09-15  
Resolution : 1.65 Å(reported)

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We welcome your comments at [validation@mail.wwpdb.org](mailto: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>.

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

MolProbity	:	4.02b-467
Mogul	:	2022.3.0, CSD as543be (2022)
Xtriage (Phenix)	:	1.20.1
EDS	:	3.0
Percentile statistics	:	20231227.v01 (using entries in the PDB archive December 27th 2023)
CCP4	:	9.0.003 (Gargrove)
Density-Fitness	:	1.0.11
Ideal geometry (proteins)	:	Engh & Huber (2001)
Ideal geometry (DNA, RNA)	:	Parkinson et al. (1996)
Validation Pipeline (wwPDB-VP)	:	2.39

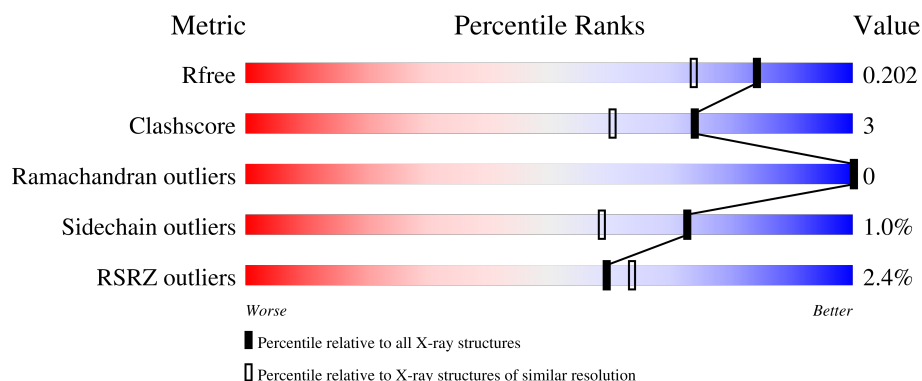
# 1 Overall quality at a glance

The following experimental techniques were used to determine the structure:

## *X-RAY DIFFRACTION*

The reported resolution of this entry is 1.65 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))
$R_{free}$	164625	2328 (1.66-1.66)
Clashscore	180529	2515 (1.66-1.66)
Ramachandran outliers	177936	2475 (1.66-1.66)
Sidechain outliers	177891	2475 (1.66-1.66)
RSRZ outliers	164620	2328 (1.66-1.66)

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  $\geq 3$ , 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  $\leq 5\%$ . 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	268	 3% 93% 5% 9%
1	B	268	 93% 6% 1%
1	C	268	 3% 90% 9% 1%

## 2 Entry composition

There are 3 unique types of molecules in this entry. The entry contains 6958 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.

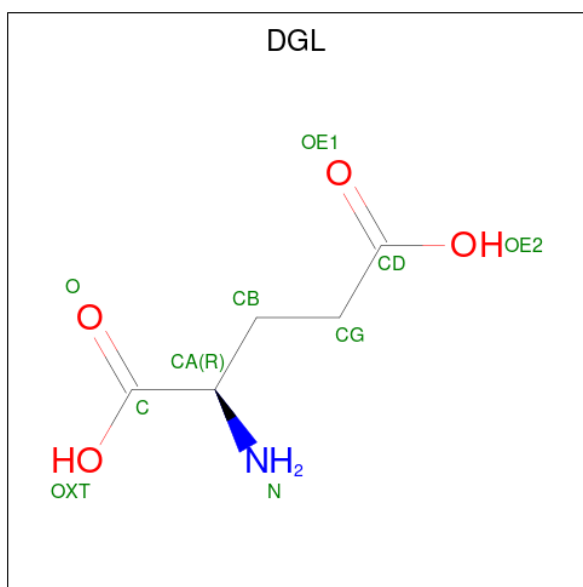
- Molecule 1 is a protein called Glutamate racemase.

Mol	Chain	Residues	Atoms						ZeroOcc	AltConf	Trace
1	A	263	Total	C	N	O	S	Se	0	7	0
			2102	1357	340	396	3	6			
1	B	264	Total	C	N	O	S	Se	0	6	0
			2107	1360	342	397	3	5			
1	C	264	Total	C	N	O	S	Se	0	8	0
			2113	1364	343	398	3	5			

There are 9 discrepancies between the modelled and reference sequences:

Chain	Residue	Modelled	Actual	Comment	Reference
A	-2	SER	-	expression tag	UNP Q5NFN6
A	-1	ASN	-	expression tag	UNP Q5NFN6
A	0	ALA	-	expression tag	UNP Q5NFN6
B	-2	SER	-	expression tag	UNP Q5NFN6
B	-1	ASN	-	expression tag	UNP Q5NFN6
B	0	ALA	-	expression tag	UNP Q5NFN6
C	-2	SER	-	expression tag	UNP Q5NFN6
C	-1	ASN	-	expression tag	UNP Q5NFN6
C	0	ALA	-	expression tag	UNP Q5NFN6

- Molecule 2 is D-GLUTAMIC ACID (three-letter code: DGL) (formula: C<sub>5</sub>H<sub>9</sub>NO<sub>4</sub>).



Mol	Chain	Residues	Atoms				ZeroOcc	AltConf
2	A	1	Total	C	N	O	0	0
			10	5	1	4		
2	B	1	Total	C	N	O	0	0
			10	5	1	4		
2	C	1	Total	C	N	O	0	0
			10	5	1	4		

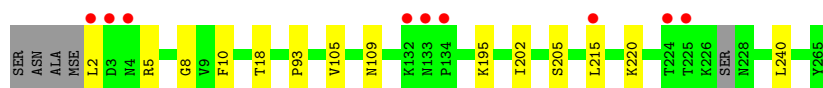
- Molecule 3 is water.

Mol	Chain	Residues	Atoms		ZeroOcc	AltConf
3	A	200	Total	O	0	1
			201	201		
3	B	210	Total	O	0	1
			211	211		
3	C	191	Total	O	0	3
			194	194		

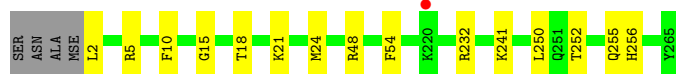
### 3 Residue-property plots [i](#)

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 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.

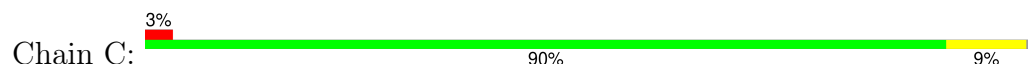
- Molecule 1: Glutamate racemase



- Molecule 1: Glutamate racemase



- Molecule 1: Glutamate racemase



## 4 Data and refinement statistics

Property	Value	Source
Space group	P 43 21 2	Depositor
Cell constants a, b, c, $\alpha$ , $\beta$ , $\gamma$	98.06Å 98.06Å 154.15Å 90.00° 90.00° 90.00°	Depositor
Resolution (Å)	25.22 – 1.65 25.22 – 1.65	Depositor EDS
% Data completeness (in resolution range)	99.9 (25.22-1.65) 99.9 (25.22-1.65)	Depositor EDS
$R_{merge}$	0.09	Depositor
$R_{sym}$	(Not available)	Depositor
$\langle I/\sigma(I) \rangle$ <sup>1</sup>	3.26 (at 1.65Å)	Xtriage
Refinement program	REFMAC 5.5.0109	Depositor
R, $R_{free}$	0.163 , 0.193 0.174 , 0.202	Depositor DCC
$R_{free}$ test set	4544 reflections (5.01%)	wwPDB-VP
Wilson B-factor (Å <sup>2</sup> )	14.5	Xtriage
Anisotropy	0.030	Xtriage
Bulk solvent $k_{sol}$ (e/Å <sup>3</sup> ), $B_{sol}$ (Å <sup>2</sup> )	0.37 , 43.6	EDS
L-test for twinning <sup>2</sup>	$\langle  L  \rangle = 0.49$ , $\langle L^2 \rangle = 0.32$	Xtriage
Estimated twinning fraction	No twinning to report.	Xtriage
$F_o, F_c$ correlation	0.96	EDS
Total number of atoms	6958	wwPDB-VP
Average B, all atoms (Å <sup>2</sup> )	16.0	wwPDB-VP

Xtriage's analysis on translational NCS is as follows: *The largest off-origin peak in the Patterson function is 4.60% of the height of the origin peak. No significant pseudotranslation is detected.*

<sup>1</sup>Intensities estimated from amplitudes.

<sup>2</sup>Theoretical 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

### 5.1 Standard geometry

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

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	0.78	1/2132 (0.0%)	0.76	0/2881
1	B	0.74	0/2139	0.78	3/2895 (0.1%)
1	C	0.69	0/2144	0.74	1/2898 (0.0%)
All	All	0.74	1/6415 (0.0%)	0.76	4/8674 (0.0%)

All (1) bond length outliers are listed below:

Mol	Chain	Res	Type	Atoms	Z	Observed(Å)	Ideal(Å)
1	A	8	GLY	C-O	-5.41	1.15	1.23

All (4) bond angle outliers are listed below:

Mol	Chain	Res	Type	Atoms	Z	Observed(°)	Ideal(°)
1	B	48	ARG	NE-CZ-NH2	-5.86	117.37	120.30
1	B	48	ARG	NE-CZ-NH1	5.38	122.99	120.30
1	B	54	PHE	CB-CG-CD2	-5.27	117.11	120.80
1	C	247	GLU	CB-CA-C	5.08	120.56	110.40

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	2102	0	2161	7	0
1	B	2107	0	2168	13	0
1	C	2113	0	2176	21	0
2	A	10	0	7	0	0
2	B	10	0	7	0	0
2	C	10	0	7	0	0
3	A	201	0	0	1	0
3	B	211	0	0	5	0
3	C	194	0	0	0	0
All	All	6958	0	6526	39	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 3.

All (39) 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:C:63:ILE:HD12	1:C:92:ILE:HD12	1.39	1.01
1:C:63:ILE:CD1	1:C:92:ILE:HD12	1.99	0.91
1:C:105:VAL:CG1	1:C:202:ILE:HD13	2.01	0.91
1:C:63:ILE:HD12	1:C:92:ILE:CD1	2.00	0.90
1:B:241:LYS:HE3	3:B:380:HOH:O	1.82	0.79
1:C:105:VAL:HG12	1:C:202:ILE:HD13	1.66	0.77
1:B:21:LYS:HA	1:B:24:MSE:CE	2.19	0.72
1:C:63:ILE:CD1	1:C:92:ILE:CD1	2.63	0.71
1:A:18[B]:THR:HG21	3:A:333:HOH:O	1.91	0.70
1:C:105:VAL:HG12	1:C:202:ILE:CD1	2.24	0.68
1:B:21:LYS:HA	1:B:24:MSE:HE3	1.75	0.67
1:B:2:LEU:HD12	1:B:5[A]:ARG:HD2	1.76	0.66
1:B:24:MSE:HE1	3:B:344:HOH:O	1.98	0.64
1:A:105:VAL:HG12	1:A:202:ILE:CD1	2.32	0.59
1:B:250:LEU:HG	1:B:252[A]:THR:HG22	1.89	0.55
1:B:15:GLY:O	1:B:18[B]:THR:HG23	2.09	0.53
1:C:120:ILE:HD12	1:C:140:SER:HB3	1.91	0.53
1:C:71:ILE:HD11	1:C:208:ALA:HB1	1.90	0.52
1:C:18[B]:THR:CG2	1:C:249:PHE:HD2	2.24	0.50
1:C:105:VAL:CG1	1:C:202:ILE:CD1	2.80	0.50
1:A:18[A]:THR:HG22	1:A:205[A]:SER:OG	2.12	0.50
1:A:240:LEU:HG	1:B:256:HIS:HB3	1.95	0.49
1:C:89[A]:ALA:O	1:C:90[A]:LYS:C	2.50	0.49
1:B:24:MSE:CE	3:B:344:HOH:O	2.59	0.48
1:A:2:LEU:HD12	1:A:5[A]:ARG:HD2	1.94	0.48

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Atom-1	Atom-2	Interatomic distance (Å)	Clash overlap (Å)
1:C:89[A]:ALA:O	1:C:90[A]:LYS:O	2.30	0.48
1:B:255:GLN:NE2	3:B:288:HOH:O	2.39	0.47
1:C:2:LEU:HD12	1:C:5:ARG:HD2	1.97	0.46
1:A:240:LEU:HD21	1:B:232:ARG:HG2	1.97	0.45
1:C:169:SER:HA	1:C:172:HIS:CD2	2.52	0.44
1:B:241:LYS:CE	3:B:380:HOH:O	2.54	0.43
1:C:71:ILE:HD11	1:C:208:ALA:CB	2.49	0.43
1:C:192:SER:O	1:C:196:ILE:HD12	2.18	0.42
1:C:23:LEU:HD22	1:C:27:LEU:HD12	2.01	0.42
1:A:93:PRO:CG	1:A:215:LEU:HD21	2.50	0.42
1:C:90[B]:LYS:O	1:C:91[B]:ALA:HB3	2.20	0.41
1:C:63:ILE:HD11	1:C:92:ILE:HD12	1.93	0.41
1:B:21:LYS:HA	1:B:24:MSE:HE2	1.99	0.41
1:C:240:LEU:HD23	1:C:240:LEU:HA	1.83	0.41

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	266/268 (99%)	263 (99%)	3 (1%)	0	100	100
1	B	268/268 (100%)	261 (97%)	7 (3%)	0	100	100
1	C	270/268 (101%)	265 (98%)	5 (2%)	0	100	100
All	All	804/804 (100%)	789 (98%)	15 (2%)	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	237/228 (104%)	233 (98%)	4 (2%)	56	35
1	B	237/228 (104%)	236 (100%)	1 (0%)	89	84
1	C	237/228 (104%)	234 (99%)	3 (1%)	65	47
All	All	711/684 (104%)	703 (99%)	8 (1%)	73	54

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

Mol	Chain	Res	Type
1	A	10	PHE
1	A	109	ASN
1	A	195	LYS
1	A	220	LYS
1	B	10	PHE
1	C	10	PHE
1	C	90[A]	LYS
1	C	90[B]	LYS

Sometimes sidechains can be flipped to improve hydrogen bonding and reduce clashes. All (1) such sidechains are listed below:

Mol	Chain	Res	Type
1	A	121	ASN

### 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 oligosaccharides in this entry.

## 5.6 Ligand geometry

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	$\# Z  > 2$
2	DGL	C	266	-	8,9,9	1.21	1 (12%)	8,11,11	1.12	1 (12%)
2	DGL	A	266	-	8,9,9	1.22	1 (12%)	8,11,11	1.26	0
2	DGL	B	266	-	8,9,9	0.91	0	8,11,11	1.11	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	DGL	C	266	-	-	0/9/9/9	-
2	DGL	A	266	-	-	0/9/9/9	-
2	DGL	B	266	-	-	0/9/9/9	-

All (2) bond length outliers are listed below:

Mol	Chain	Res	Type	Atoms	Z	Observed(Å)	Ideal(Å)
2	C	266	DGL	OXT-C	-2.66	1.22	1.30
2	A	266	DGL	OXT-C	-2.13	1.23	1.30

All (1) bond angle outliers are listed below:

Mol	Chain	Res	Type	Atoms	Z	Observed(°)	Ideal(°)
2	C	266	DGL	CB-CA-N	2.11	115.62	110.12

There are no chirality outliers.

There are no torsion outliers.

There are no ring outliers.

No monomer is involved in short contacts.

## 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

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, 95<sup>th</sup> 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(Å <sup>2</sup> )	Q<0.9
1	A	258/268 (96%)	-0.13	9 (3%)	47	51	5, 15, 29, 36	6 (2%)
1	B	259/268 (96%)	-0.46	1 (0%)	89	92	6, 12, 25, 32	6 (2%)
1	C	259/268 (96%)	-0.16	9 (3%)	47	51	5, 14, 31, 43	8 (3%)
All	All	776/804 (96%)	-0.25	19 (2%)	59	63	5, 14, 29, 43	20 (2%)

All (19) RSRZ outliers are listed below:

Mol	Chain	Res	Type	RSRZ
1	C	221	LEU	3.4
1	A	4	ASN	3.0
1	C	219	ASN	3.0
1	A	2	LEU	3.0
1	C	217	PHE	2.8
1	C	240	LEU	2.7
1	C	218	GLU	2.6
1	C	89[A]	ALA	2.6
1	A	225	THR	2.6
1	C	220	LYS	2.6
1	A	3	ASP	2.5
1	C	255	GLN	2.5
1	A	224	THR	2.2
1	A	132	LYS	2.2
1	B	220	LYS	2.2
1	C	224	THR	2.2
1	A	215	LEU	2.2
1	A	133	ASN	2.1
1	A	134	PRO	2.0

## 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 monosaccharides 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. The B-factors column lists the minimum, median, 95<sup>th</sup> 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( $\text{\AA}^2$ )	Q<0.9
2	DGL	A	266	10/10	0.95	0.06	9,10,11,11	0
2	DGL	C	266	10/10	0.97	0.05	8,9,9,9	0
2	DGL	B	266	10/10	0.98	0.03	6,8,8,9	0

## 6.5 Other polymers [i](#)

There are no such residues in this entry.