



# Full wwPDB X-ray Structure Validation Report ⓘ

Nov 24, 2025 – 12:03 pm GMT

PDB ID : 9RF1 / pdb\_00009rf1  
Title : Structure of human GPX4-U46C-R152K mutant  
Authors : Mourao, A.; Sattler, M.; Popowicz, G.  
Deposited on : 2025-06-04  
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](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>.

---

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

MolProbity	:	4-5-2 with Phenix2.0
Xtriage (Phenix)	:	2.0
EDS	:	3.0
Percentile statistics	:	20231227.v01 (using entries in the PDB archive December 27th 2023)
CCP4	:	9.0.010 (Gargrove)
Density-Fitness	:	1.0.12
Ideal geometry (proteins)	:	Engh & Huber (2001)
Ideal geometry (DNA, RNA)	:	Parkinson et al. (1996)
Validation Pipeline (wwPDB-VP)	:	2.46

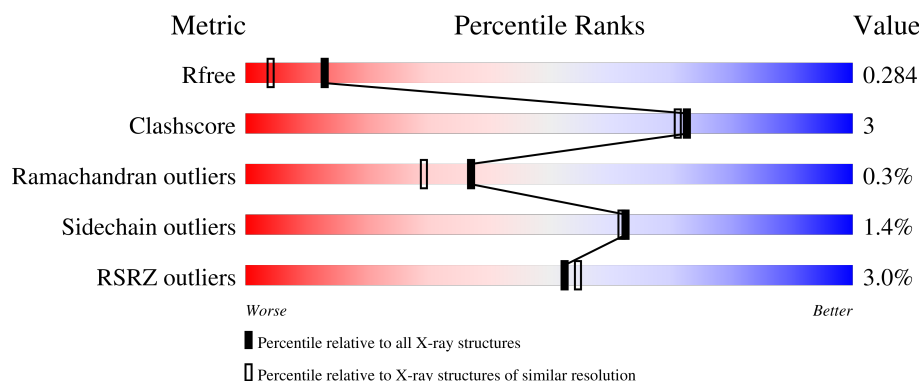
# 1 Overall quality at a glance

The following experimental techniques were used to determine the structure:

*X-RAY DIFFRACTION*

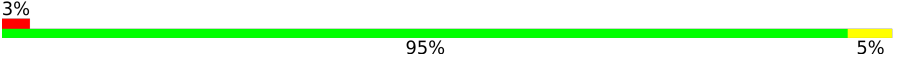

The reported resolution of this entry is 1.90 Å.

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))
$R_{free}$	164625	7293 (1.90-1.90)
Clashscore	180529	8090 (1.90-1.90)
Ramachandran outliers	177936	8022 (1.90-1.90)
Sidechain outliers	177891	8022 (1.90-1.90)
RSRZ outliers	164620	7292 (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  $\geq 3$ , 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	172	 3% 95% 5%
1	B	172	 3% 85% 9% • 5%

## 2 Entry composition

There are 2 unique types of molecules in this entry. The entry contains 2886 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 Phospholipid hydroperoxide glutathione peroxidase GPX4.

Mol	Chain	Residues	Atoms					ZeroOcc	AltConf	Trace
1	A	172	Total	C	N	O	S	0	0	0
			1359	868	231	246	14			
1	B	163	Total	C	N	O	S	0	0	0
			1299	833	219	235	12			

There are 8 discrepancies between the modelled and reference sequences:

Chain	Residue	Modelled	Actual	Comment	Reference
A	-1	GLY	-	expression tag	UNP P36969
A	0	ALA	-	expression tag	UNP P36969
A	46	CYS	SEC	engineered mutation	UNP P36969
A	152	LYS	ARG	engineered mutation	UNP P36969
B	-1	GLY	-	expression tag	UNP P36969
B	0	ALA	-	expression tag	UNP P36969
B	46	CYS	SEC	engineered mutation	UNP P36969
B	152	LYS	ARG	engineered mutation	UNP P36969

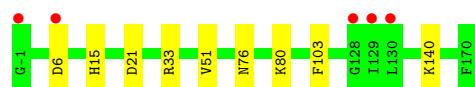
- Molecule 2 is water.

Mol	Chain	Residues	Atoms		ZeroOcc	AltConf
2	A	130	Total	O	0	0
			130	130		
2	B	98	Total	O	0	0
			98	98		

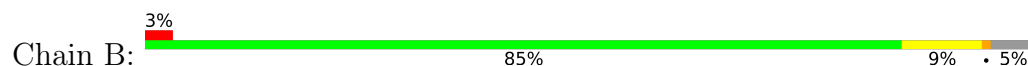
### 3 Residue-property plots [i](#)

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: Phospholipid hydroperoxide glutathione peroxidase GPX4



- Molecule 1: Phospholipid hydroperoxide glutathione peroxidase GPX4



## 4 Data and refinement statistics

Property	Value	Source
Space group	P 1 21 1	Depositor
Cell constants a, b, c, $\alpha$ , $\beta$ , $\gamma$	35.39Å 62.95Å 75.44Å 90.00° 100.79° 90.00°	Depositor
Resolution (Å)	37.00 – 1.90 37.00 – 1.90	Depositor EDS
% Data completeness (in resolution range)	98.7 (37.00-1.90) 88.7 (37.00-1.90)	Depositor EDS
$R_{merge}$	(Not available)	Depositor
$R_{sym}$	(Not available)	Depositor
$\langle I/\sigma(I) \rangle$ <sup>1</sup>	0.39 (at 1.91Å)	Xtriage
Refinement program	PHENIX 1.21.2_5419	Depositor
R, $R_{free}$	0.215 , 0.284 0.215 , 0.284	Depositor DCC
$R_{free}$ test set	1357 reflections (5.32%)	wwPDB-VP
Wilson B-factor (Å <sup>2</sup> )	16.0	Xtriage
Anisotropy	0.537	Xtriage
Bulk solvent $k_{sol}$ (e/Å <sup>3</sup> ), $B_{sol}$ (Å <sup>2</sup> )	0.35 , 44.5	EDS
L-test for twinning <sup>2</sup>	$\langle  L  \rangle = 0.50$ , $\langle L^2 \rangle = 0.33$	Xtriage
Estimated twinning fraction	0.105 for h,-k,-h-l	Xtriage
$F_o, F_c$ correlation	0.93	EDS
Total number of atoms	2886	wwPDB-VP
Average B, all atoms (Å <sup>2</sup> )	24.0	wwPDB-VP

Xtriage's analysis on translational NCS is as follows: *The largest off-origin peak in the Patterson function is 8.38% 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

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	0.32	0/1394	0.50	0/1879
1	B	0.29	0/1333	0.47	0/1795
All	All	0.31	0/2727	0.49	0/3674

There are no bond length outliers.

There are no bond angle outliers.

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	1359	0	1311	7	0
1	B	1299	0	1249	9	0
2	A	130	0	0	1	0
2	B	98	0	0	2	0
All	All	2886	0	2560	16	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 (16) 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:A:76:ASN:HD21	1:A:80:LYS:NZ	2.00	0.59

*Continued on next page...*

Continued from previous page...

Atom-1	Atom-2	Interatomic distance (Å)	Clash overlap (Å)
1:A:51:VAL:HG12	2:A:250:HOH:O	2.09	0.53
1:B:125:LYS:HD2	1:B:150:VAL:HA	1.90	0.52
1:B:46:CYS:HB2	1:B:81:GLN:OE1	2.09	0.52
1:A:21:ASP:HA	1:A:103:PHE:HA	1.91	0.51
1:B:21:ASP:HA	1:B:103:PHE:HA	1.96	0.47
1:A:15:HIS:CE1	1:A:33:ARG:HA	2.51	0.46
1:B:136:TRP:CG	1:B:137:ASN:H	2.35	0.45
1:A:76:ASN:HD21	1:A:80:LYS:HZ1	1.65	0.44
1:B:6:ASP:HB3	1:B:7:ASP:H	1.53	0.43
1:B:15:HIS:HB3	1:B:30:ASP:HA	2.01	0.42
1:A:80:LYS:HE3	1:A:80:LYS:HB3	1.70	0.42
1:B:151:LYS:HE2	2:B:258:HOH:O	2.19	0.42
1:B:6:ASP:HA	2:B:278:HOH:O	2.20	0.41
1:A:76:ASN:HD21	1:A:80:LYS:HZ2	1.66	0.40
1:B:14:MET:HG3	1:B:116:LEU:HD11	2.04	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	170/172 (99%)	165 (97%)	5 (3%)	0	100	100
1	B	159/172 (92%)	155 (98%)	3 (2%)	1 (1%)	22	13
All	All	329/344 (96%)	320 (97%)	8 (2%)	1 (0%)	37	29

All (1) Ramachandran outliers are listed below:

Mol	Chain	Res	Type
1	B	126	GLY

### 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	143/146 (98%)	141 (99%)	2 (1%)	62	62
1	B	137/146 (94%)	135 (98%)	2 (2%)	60	59
All	All	280/292 (96%)	276 (99%)	4 (1%)	62	62

All (4) residues with a non-rotameric sidechain are listed below:

Mol	Chain	Res	Type
1	A	6	ASP
1	A	140	LYS
1	B	46	CYS
1	B	58	ASP

Sometimes sidechains can be flipped to improve hydrogen bonding and reduce clashes. All (4) such sidechains are listed below:

Mol	Chain	Res	Type
1	A	76	ASN
1	A	81	GLN
1	A	97	ASN
1	B	146	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

There are no ligands in this entry.

## 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 [i](#)

### 6.1 Protein, DNA and RNA chains [i](#)

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	172/172 (100%)	0.34	5 (2%) 54 56	14, 21, 37, 49	0
1	B	163/172 (94%)	0.43	5 (3%) 51 53	17, 24, 37, 58	0
All	All	335/344 (97%)	0.38	10 (2%) 52 55	14, 23, 37, 58	0

All (10) RSRZ outliers are listed below:

Mol	Chain	Res	Type	RSRZ
1	A	130	LEU	4.4
1	B	131	GLY	4.0
1	A	129	ILE	4.0
1	B	126	GLY	2.9
1	A	-1	GLY	2.7
1	B	128	GLY	2.7
1	A	128	GLY	2.3
1	B	127	LYS	2.3
1	A	6	ASP	2.3
1	B	132	ASN	2.1

### 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 oligosaccharides in this entry.

### 6.4 Ligands [i](#)

There are no ligands in this entry.

## 6.5 Other polymers [i](#)

There are no such residues in this entry.