



# Full wwPDB X-ray Structure Validation Report ⓘ

Jun 17, 2024 – 03:53 AM EDT

PDB ID : 5IAA  
Title : Crystal structure of human UBA5 in complex with UFM1  
Authors : Oweis, W.; Padala, P.; Wiener, R.  
Deposited on : 2016-02-21  
Resolution : 1.85 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>.

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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  
Xtriage (Phenix) : 1.13  
EDS : 2.37.1  
Percentile statistics : 20191225.v01 (using entries in the PDB archive December 25th 2019)  
Refmac : 5.8.0158  
CCP4 : 7.0.044 (Gargrove)  
Ideal geometry (proteins) : Engh & Huber (2001)  
Ideal geometry (DNA, RNA) : Parkinson et al. (1996)  
Validation Pipeline (wwPDB-VP) : 2.37.1

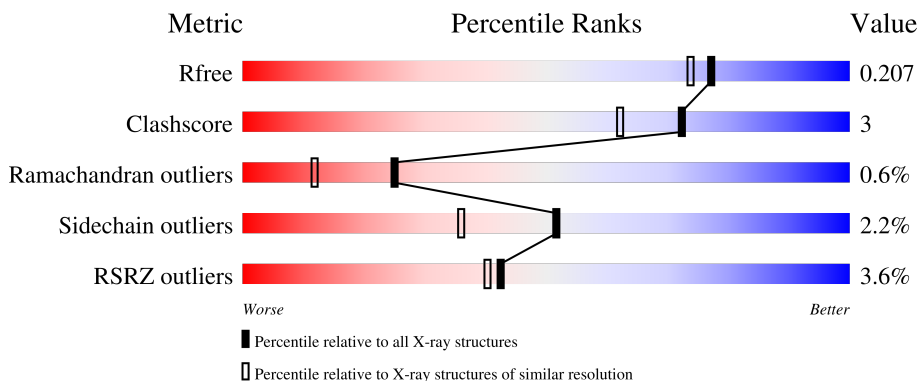
# 1 Overall quality at a glance

The following experimental techniques were used to determine the structure:

*X-RAY DIFFRACTION*

The reported resolution of this entry is 1.85 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))
$R_{free}$	130704	2469 (1.86-1.86)
Clashscore	141614	2625 (1.86-1.86)
Ramachandran outliers	138981	2592 (1.86-1.86)
Sidechain outliers	138945	2592 (1.86-1.86)
RSRZ outliers	127900	2436 (1.86-1.86)

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	290	 5% 81% 8% 10%
1	B	290	 3% 75% 7% 18%
2	C	83	 84% 12%
2	D	83	 82% 14%

## 2 Entry composition [i](#)

There are 4 unique types of molecules in this entry. The entry contains 5218 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 Ubiquitin-like modifier-activating enzyme 5.

Mol	Chain	Residues	Atoms					ZeroOcc	AltConf	Trace
			Total	C	N	O	S			
1	A	260	2010	1275	336	383	16	0	0	0
1	B	239	1846	1168	309	354	15	0	0	0

- Molecule 2 is a protein called Ubiquitin-fold modifier 1.

Mol	Chain	Residues	Atoms				ZeroOcc	AltConf	Trace
			Total	C	N	O			
2	C	80	607	391	103	113	0	0	0
2	D	80	607	391	103	113	0	0	0

- Molecule 3 is ZINC ION (three-letter code: ZN) (formula: Zn).

Mol	Chain	Residues	Atoms		ZeroOcc	AltConf
3	A	1	Total	Zn	0	0
			1	1		
3	B	1	Total	Zn	0	0
			1	1		

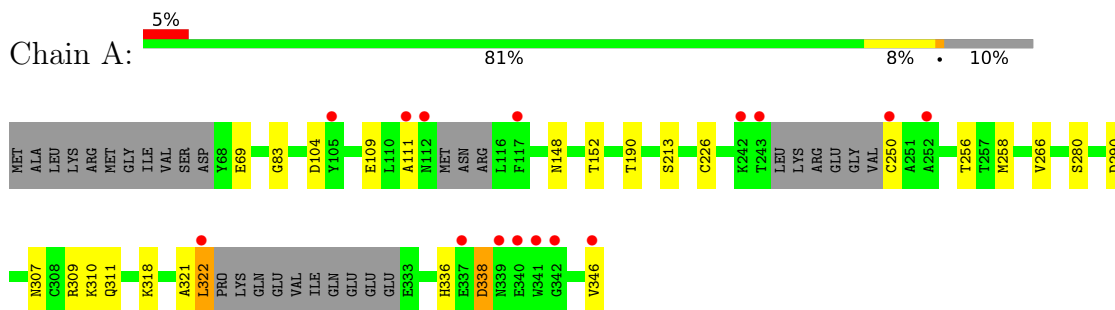
- Molecule 4 is water.

Mol	Chain	Residues	Atoms		ZeroOcc	AltConf
4	A	64	Total	O	0	0
			64	64		
4	B	51	Total	O	0	0
			51	51		
4	C	12	Total	O	0	0
			12	12		
4	D	19	Total	O	0	0
			19	19		

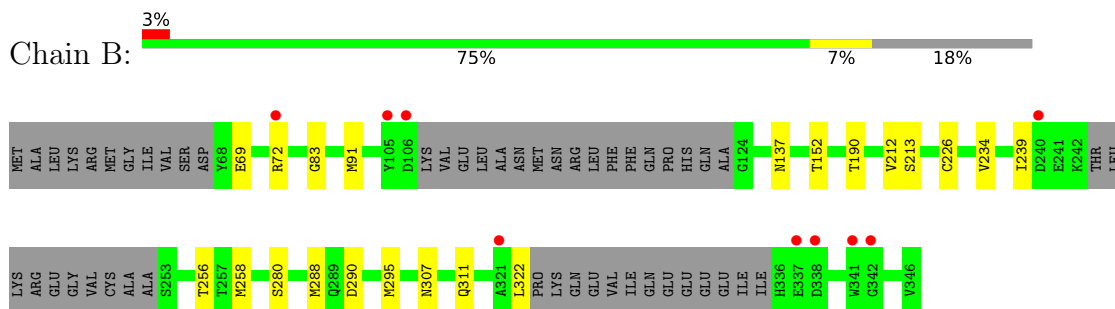
### 3 Residue-property plots [i](#)

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.

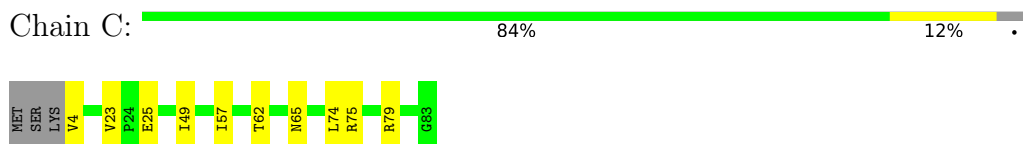
- Molecule 1: Ubiquitin-like modifier-activating enzyme 5



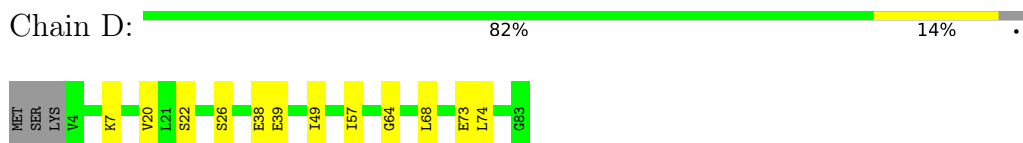
- Molecule 1: Ubiquitin-like modifier-activating enzyme 5



- Molecule 2: Ubiquitin-fold modifier 1



- Molecule 2: Ubiquitin-fold modifier 1



## 4 Data and refinement statistics

Property	Value	Source
Space group	P 32 2 1	Depositor
Cell constants a, b, c, $\alpha$ , $\beta$ , $\gamma$	138.08Å 138.08Å 99.18Å 90.00° 90.00° 120.00°	Depositor
Resolution (Å)	69.04 – 1.85 69.04 – 1.85	Depositor EDS
% Data completeness (in resolution range)	100.0 (69.04-1.85) 100.0 (69.04-1.85)	Depositor EDS
$R_{merge}$	0.17	Depositor
$R_{sym}$	(Not available)	Depositor
$\langle I/\sigma(I) \rangle$ <sup>1</sup>	1.94 (at 1.86Å)	Xtriage
Refinement program	REFMAC 5.8.0135	Depositor
R, $R_{free}$	0.187 , 0.206 0.192 , 0.207	Depositor DCC
$R_{free}$ test set	4656 reflections (5.01%)	wwPDB-VP
Wilson B-factor (Å <sup>2</sup> )	28.2	Xtriage
Anisotropy	0.372	Xtriage
Bulk solvent $k_{sol}$ (e/Å <sup>3</sup> ), $B_{sol}$ (Å <sup>2</sup> )	0.37 , 38.7	EDS
L-test for twinning <sup>2</sup>	$\langle  L  \rangle = 0.44$ , $\langle L^2 \rangle = 0.26$	Xtriage
Estimated twinning fraction	0.111 for -h,-k,l	Xtriage
Reported twinning fraction	0.871 for H, K, L 0.129 for -h,-k,l	Depositor
Outliers	0 of 93002 reflections	Xtriage
$F_o, F_c$ correlation	0.96	EDS
Total number of atoms	5218	wwPDB-VP
Average B, all atoms (Å <sup>2</sup> )	42.0	wwPDB-VP

Xtriage's analysis on translational NCS is as follows: *The largest off-origin peak in the Patterson function is 3.85% 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 [i](#)

### 5.1 Standard geometry [i](#)

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

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	0.79	0/2046	0.89	3/2769 (0.1%)
1	B	0.79	0/1878	0.86	1/2540 (0.0%)
2	C	0.65	0/620	0.86	2/843 (0.2%)
2	D	0.72	0/620	0.84	0/843
All	All	0.76	0/5164	0.87	6/6995 (0.1%)

There are no bond length outliers.

All (6) bond angle outliers are listed below:

Mol	Chain	Res	Type	Atoms	Z	Observed(°)	Ideal(°)
1	A	309	ARG	NE-CZ-NH1	6.75	123.67	120.30
1	A	309	ARG	NE-CZ-NH2	-6.64	116.98	120.30
2	C	75	ARG	NE-CZ-NH1	5.93	123.27	120.30
1	B	295	MET	CG-SD-CE	5.43	108.89	100.20
1	A	309	ARG	CG-CD-NE	-5.18	100.93	111.80
2	C	79	ARG	NE-CZ-NH2	-5.15	117.73	120.30

There are no chirality outliers.

There are no planarity outliers.

### 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	2010	0	1972	18	0

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Mol	Chain	Non-H	H(model)	H(added)	Clashes	Symm-Clashes
1	B	1846	0	1808	13	1
2	C	607	0	628	6	0
2	D	607	0	628	8	0
3	A	1	0	0	0	0
3	B	1	0	0	0	0
4	A	64	0	0	0	0
4	B	51	0	0	0	0
4	C	12	0	0	0	0
4	D	19	0	0	0	0
All	All	5218	0	5036	34	1

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 (34) 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:C:25:GLU:O	2:C:62:THR:OG1	2.06	0.74
1:A:290:ASP:OD2	1:B:280:SER:OG	2.10	0.69
2:C:62:THR:HG23	2:C:65:ASN:H	1.61	0.64
1:A:280:SER:OG	1:B:290:ASP:OD2	2.15	0.64
2:D:7:LYS:HG2	2:D:20:VAL:HG22	1.81	0.61
1:A:256:THR:HA	1:B:91:MET:CE	2.35	0.56
2:D:7:LYS:HE3	2:D:73:GLU:OE2	2.07	0.55
1:A:152:THR:HG22	1:A:190:THR:OG1	2.10	0.52
1:B:152:THR:HG22	1:B:190:THR:OG1	2.09	0.51
1:B:212:VAL:HG13	1:B:288:MET:HG2	1.92	0.51
1:A:336:HIS:HD2	2:D:38:GLU:OE1	1.94	0.49
2:D:57:ILE:CD1	2:D:74:LEU:HD22	2.43	0.49
2:C:4:VAL:HG23	2:C:23:VAL:HG13	1.93	0.48
2:D:49:ILE:HG23	2:D:57:ILE:HB	1.96	0.48
1:A:321:ALA:O	1:A:322:LEU:HD22	2.14	0.48
2:C:62:THR:HG22	2:C:65:ASN:HD22	1.78	0.48
1:A:256:THR:HA	1:B:91:MET:HE1	1.94	0.48
1:A:104:ASP:O	1:A:148:ASN:HA	2.14	0.47
1:A:256:THR:HG23	1:B:91:MET:HE1	1.96	0.47
2:C:57:ILE:CD1	2:C:74:LEU:HD22	2.46	0.46
1:A:336:HIS:HE1	2:D:39:GLU:OE2	1.98	0.46
1:A:266:VAL:HG12	1:B:256:THR:HG21	1.98	0.45
1:A:256:THR:HA	1:B:91:MET:HE3	1.98	0.45
2:C:49:ILE:HG23	2:C:57:ILE:HB	1.99	0.44

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Atom-1	Atom-2	Interatomic distance (Å)	Clash overlap (Å)
1:A:318:LYS:CG	1:A:322:LEU:HD23	2.48	0.44
1:A:318:LYS:HG2	1:A:322:LEU:HD23	2.00	0.43
1:B:307:ASN:O	1:B:311:GLN:HG2	2.19	0.43
1:A:307:ASN:O	1:A:311:GLN:HG2	2.19	0.43
2:D:64:GLY:O	2:D:68:LEU:HD23	2.21	0.41
1:B:234:VAL:HG23	1:B:239:ILE:HB	2.03	0.41
1:B:83:GLY:HA3	1:B:258:MET:SD	2.62	0.40
1:A:256:THR:HG23	1:B:91:MET:CE	2.51	0.40
1:A:346:VAL:HG21	2:D:22:SER:HB2	2.03	0.40
1:A:83:GLY:HA3	1:A:258:MET:SD	2.62	0.40

All (1) symmetry-related close contacts are listed below. The label for Atom-2 includes the symmetry operator and encoded unit-cell translations to be applied.

Atom-1	Atom-2	Interatomic distance (Å)	Clash overlap (Å)
1:B:137:ASN:OD1	1:B:137:ASN:OD1[5_555]	1.80	0.40

## 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	252/290 (87%)	242 (96%)	7 (3%)	3 (1%)	13	3
1	B	231/290 (80%)	227 (98%)	3 (1%)	1 (0%)	34	19
2	C	78/83 (94%)	77 (99%)	1 (1%)	0	100	100
2	D	78/83 (94%)	76 (97%)	2 (3%)	0	100	100
All	All	639/746 (86%)	622 (97%)	13 (2%)	4 (1%)	25	12

All (4) Ramachandran outliers are listed below:



Mol	Chain	Res	Type
1	A	111	ALA
1	A	69	GLU
1	A	338	ASP
1	B	69	GLU

### 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	220/247 (89%)	213 (97%)	7 (3%)	39	22
1	B	203/247 (82%)	199 (98%)	4 (2%)	55	40
2	C	67/70 (96%)	67 (100%)	0	100	100
2	D	67/70 (96%)	66 (98%)	1 (2%)	65	53
All	All	557/634 (88%)	545 (98%)	12 (2%)	52	36

All (12) residues with a non-rotameric sidechain are listed below:

Mol	Chain	Res	Type
1	A	109	GLU
1	A	213	SER
1	A	226	CYS
1	A	250	CYS
1	A	310	LYS
1	A	322	LEU
1	A	338	ASP
1	B	72	ARG
1	B	213	SER
1	B	226	CYS
1	B	322	LEU
2	D	26	SER

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	148	ASN

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Mol	Chain	Res	Type
1	A	336	HIS
1	B	302	GLN
2	D	65	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 monosaccharides in this entry.

### 5.6 Ligand geometry [i](#)

Of 2 ligands modelled in this entry, 2 are monoatomic - leaving 0 for Mogul analysis.

There are no bond length outliers.

There are no bond angle outliers.

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	260/290 (89%)	0.27	15 (5%) 23 22	23, 34, 84, 114	0
1	B	239/290 (82%)	0.17	9 (3%) 40 38	23, 36, 76, 102	0
2	C	80/83 (96%)	0.24	0 100 100	36, 49, 58, 65	0
2	D	80/83 (96%)	-0.11	0 100 100	30, 39, 51, 56	0
All	All	659/746 (88%)	0.19	24 (3%) 42 40	23, 38, 75, 114	0

All (24) RSRZ outliers are listed below:

Mol	Chain	Res	Type	RSRZ
1	A	337	GLU	4.8
1	A	322	LEU	4.1
1	A	250	CYS	4.0
1	B	105	TYR	3.9
1	A	243	THR	3.8
1	A	111	ALA	3.6
1	B	342	GLY	3.6
1	A	105	TYR	3.5
1	A	117	PHE	3.4
1	B	240	ASP	3.4
1	B	337	GLU	3.4
1	B	338	ASP	3.3
1	B	72	ARG	2.8
1	B	341	TRP	2.7
1	B	106	ASP	2.4
1	A	339	ASN	2.3
1	A	242	LYS	2.3
1	A	112	ASN	2.2
1	A	341	TRP	2.2
1	A	342	GLY	2.2
1	A	252	ALA	2.2

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Mol	Chain	Res	Type	RSRZ
1	A	340	GLU	2.2
1	A	346	VAL	2.1
1	B	321	ALA	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 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(Å <sup>2</sup> )	Q<0.9
3	ZN	A	401	1/1	0.96	0.17	33,33,33,33	0
3	ZN	B	401	1/1	0.98	0.15	37,37,37,37	0

## 6.5 Other polymers [i](#)

There are no such residues in this entry.