



# wwPDB X-ray Structure Validation Summary Report ⓘ

Nov 16, 2024 – 10:11 PM EST

PDB ID : 3QFD  
Title : Human Class I MHC HLA-A2 in complex with Mart-1(27-35) nonameric peptide  
Authors : Borbulevych, O.Y.; Baker, B.M.  
Deposited on : 2011-01-21  
Resolution : 1.68 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](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

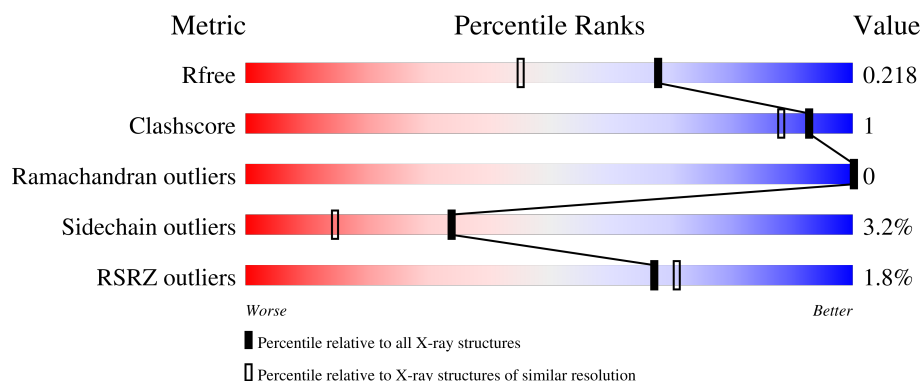
# 1 Overall quality at a glance

The following experimental techniques were used to determine the structure:

*X-RAY DIFFRACTION*

The reported resolution of this entry is 1.68 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.



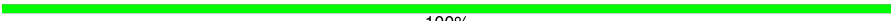
Metric	Whole archive (#Entries)	Similar resolution (#Entries, resolution range(Å))
$R_{free}$	164625	8422 (1.70-1.66)
Clashscore	180529	1005 (1.68-1.68)
Ramachandran outliers	177936	9065 (1.70-1.66)
Sidechain outliers	177891	9064 (1.70-1.66)
RSRZ outliers	164620	8421 (1.70-1.66)

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	275	<div> <div>3%</div> <div>93%</div> <div>6%</div> </div>
1	D	275	<div> <div>%</div> <div>94%</div> <div>5%</div> </div>
2	B	100	<div> <div>%</div> <div>93%</div> <div>7%</div> </div>
2	E	100	<div> <div>%</div> <div>96%</div> <div>%</div> </div>
3	C	9	<div> <div>11%</div> <div>100%</div> </div>

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Mol	Chain	Length	Quality of chain
3	F	9	 100%

## 2 Entry composition [i](#)

There are 6 unique types of molecules in this entry. The entry contains 7271 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 HLA class I histocompatibility antigen, A-2 alpha chain.

Mol	Chain	Residues	Atoms					ZeroOcc	AltConf	Trace
1	A	275	Total	C	N	O	S	0	15	0
			2309	1445	413	442	9			
1	D	275	Total	C	N	O	S	0	8	0
			2280	1427	410	434	9			

- Molecule 2 is a protein called Beta-2-microglobulin.

Mol	Chain	Residues	Atoms					ZeroOcc	AltConf	Trace
2	B	100	Total	C	N	O	S	0	6	0
			858	547	143	163	5			
2	E	100	Total	C	N	O	S	0	4	0
			853	545	141	162	5			

There are 2 discrepancies between the modelled and reference sequences:

Chain	Residue	Modelled	Actual	Comment	Reference
B	0	MET	-	initiating methionine	UNP P61769
E	0	MET	-	initiating methionine	UNP P61769

- Molecule 3 is a protein called Mart-1(27-35) peptide.

Mol	Chain	Residues	Atoms				ZeroOcc	AltConf	Trace
3	C	9	Total	C	N	O	0	0	0
			57	37	9	11			
3	F	9	Total	C	N	O	0	1	0
			60	39	9	12			

- Molecule 4 is GLYCEROL (three-letter code: GOL) (formula: C<sub>3</sub>H<sub>8</sub>O<sub>3</sub>).



Mol	Chain	Residues	Atoms			ZeroOcc	AltConf
4	A	1	Total	C	O	0	0
			6	3	3		
4	A	1	Total	C	O	0	0
			6	3	3		
4	A	1	Total	C	O	0	0
			6	3	3		
4	B	1	Total	C	O	0	0
			6	3	3		
4	D	1	Total	C	O	0	0
			6	3	3		
4	D	1	Total	C	O	0	0
			6	3	3		

- Molecule 5 is SODIUM ION (three-letter code: NA) (formula: Na).

Mol	Chain	Residues	Atoms		ZeroOcc	AltConf
5	B	1	Total	Na	0	0
			1	1		
5	E	1	Total	Na	0	0
			1	1		

- Molecule 6 is water.

Mol	Chain	Residues	Atoms		ZeroOcc	AltConf
6	A	264	Total	O	0	0
			264	264		

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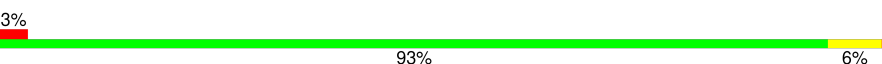
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Mol	Chain	Residues	Atoms		ZeroOcc	AltConf
6	B	119	Total 120	O 120	0	1
6	C	8	Total 8	O 8	0	0
6	D	287	Total 287	O 287	0	0
6	E	125	Total 125	O 125	0	0
6	F	12	Total 12	O 12	0	0

### 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 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.

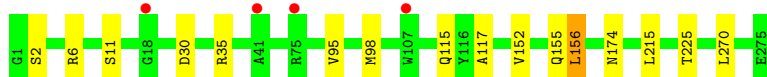
- Molecule 1: HLA class I histocompatibility antigen, A-2 alpha chain

Chain A: 



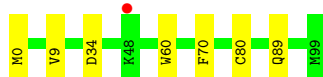
- Molecule 1: HLA class I histocompatibility antigen, A-2 alpha chain

Chain D: 



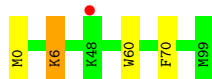
- Molecule 2: Beta-2-microglobulin

Chain B: 



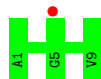
- Molecule 2: Beta-2-microglobulin

Chain E: 



- Molecule 3: Mart-1(27-35) peptide

Chain C: 



- Molecule 3: Mart-1(27-35) peptide

Chain F:  100%

There are no outlier residues recorded for this chain.



## 4 Data and refinement statistics

Property	Value	Source
Space group	P 1 21 1	Depositor
Cell constants a, b, c, $\alpha$ , $\beta$ , $\gamma$	58.25Å 84.12Å 83.96Å 90.00° 90.05° 90.00°	Depositor
Resolution (Å)	20.00 – 1.68 20.00 – 1.68	Depositor EDS
% Data completeness (in resolution range)	98.5 (20.00-1.68) 98.5 (20.00-1.68)	Depositor EDS
$R_{merge}$	0.08	Depositor
$R_{sym}$	(Not available)	Depositor
$\langle I/\sigma(I) \rangle$ <sup>1</sup>	2.03 (at 1.68Å)	Xtriage
Refinement program	REFMAC	Depositor
R, $R_{free}$	0.170 , 0.211 0.182 , 0.218	Depositor DCC
$R_{free}$ test set	4543 reflections (5.01%)	wwPDB-VP
Wilson B-factor (Å <sup>2</sup> )	15.7	Xtriage
Anisotropy	0.118	Xtriage
Bulk solvent $k_{sol}$ (e/Å <sup>3</sup> ), $B_{sol}$ (Å <sup>2</sup> )	0.37 , 35.5	EDS
L-test for twinning <sup>2</sup>	$\langle  L  \rangle = 0.49$ , $\langle L^2 \rangle = 0.32$	Xtriage
Estimated twinning fraction	0.017 for -h,-l,-k 0.010 for -h,l,k 0.128 for h,-k,-l	Xtriage
$F_o, F_c$ correlation	0.95	EDS
Total number of atoms	7271	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 5.51% 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: GOL, NA

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	0.74	1/2414 (0.0%)	0.85	6/3275 (0.2%)
1	D	0.70	0/2372	0.85	2/3220 (0.1%)
2	B	0.74	0/905	0.80	0/1222
2	E	0.73	0/890	0.80	0/1202
3	C	0.82	0/56	0.73	0/74
3	F	0.82	0/63	0.76	0/84
All	All	0.73	1/6700 (0.0%)	0.83	8/9077 (0.1%)

All (1) bond length outliers are listed below:

Mol	Chain	Res	Type	Atoms	Z	Observed(Å)	Ideal(Å)
1	A	95	VAL	CB-CG2	-5.75	1.40	1.52

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

Mol	Chain	Res	Type	Atoms	Z	Observed(°)	Ideal(°)
1	A	97	ARG	NE-CZ-NH1	-6.91	116.85	120.30
1	A	97	ARG	NE-CZ-NH2	6.67	123.64	120.30
1	A	110	LEU	CA-CB-CG	6.00	129.10	115.30
1	A	156	LEU	CB-CG-CD1	5.92	121.07	111.00
1	D	270	LEU	CB-CG-CD1	-5.68	101.34	111.00

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	2309	0	2174	6	0
1	D	2280	0	2139	7	0
2	B	858	0	814	4	0
2	E	853	0	822	2	0
3	C	57	0	67	0	0
3	F	60	0	70	0	0
4	A	18	0	24	2	0
4	B	6	0	8	0	0
4	D	12	0	16	1	0
5	B	1	0	0	0	0
5	E	1	0	0	0	0
6	A	264	0	0	3	0
6	B	120	0	0	1	0
6	C	8	0	0	0	0
6	D	287	0	0	0	0
6	E	125	0	0	0	0
6	F	12	0	0	0	0
All	All	7271	0	6134	17	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 1.

The worst 5 of 17 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:157:ARG:NH1	6:A:336:HOH:O	2.26	0.69
2:B:9[B]:VAL:HG11	2:B:80:CYS:HB3	1.87	0.56
1:A:108:ARG:NH1	1:D:174:ASN:OD1	2.43	0.52
2:B:34[A]:ASP:OD2	6:B:803:HOH:O	2.20	0.50
1:D:117:ALA:HB2	2:E:60:TRP:CE2	2.50	0.46

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	288/275 (105%)	283 (98%)	5 (2%)	0	100	100
1	D	281/275 (102%)	278 (99%)	3 (1%)	0	100	100
2	B	103/100 (103%)	102 (99%)	1 (1%)	0	100	100
2	E	101/100 (101%)	100 (99%)	1 (1%)	0	100	100
3	C	7/9 (78%)	7 (100%)	0	0	100	100
3	F	8/9 (89%)	8 (100%)	0	0	100	100
All	All	788/768 (103%)	778 (99%)	10 (1%)	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	244/231 (106%)	232 (95%)	12 (5%)	21	6
1	D	239/231 (104%)	232 (97%)	7 (3%)	37	18
2	B	101/95 (106%)	97 (96%)	4 (4%)	27	9
2	E	99/95 (104%)	95 (96%)	4 (4%)	27	9
3	C	5/5 (100%)	5 (100%)	0	100	100
3	F	6/5 (120%)	6 (100%)	0	100	100
All	All	694/662 (105%)	667 (96%)	27 (4%)	34	10

5 of 27 residues with a non-rotameric sidechain are listed below:

Mol	Chain	Res	Type
2	B	70	PHE
1	D	35	ARG
2	E	0[B]	MET

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Mol	Chain	Res	Type
1	D	2	SER
1	D	115	GLN

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	72	GLN
1	A	155	GLN
1	D	115	GLN
1	D	155	GLN

### 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 8 ligands modelled in this entry, 2 are monoatomic - leaving 6 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	$\# Z  > 2$
4	GOL	B	100	-	5,5,5	0.45	0	5,5,5	1.92	1 (20%)
4	GOL	A	277	-	5,5,5	0.71	0	5,5,5	1.44	0

Mol	Type	Chain	Res	Link	Bond lengths			Bond angles		
					Counts	RMSZ	# Z  > 2	Counts	RMSZ	# Z  > 2
4	GOL	D	277	-	5,5,5	0.27	0	5,5,5	0.96	0
4	GOL	A	278	-	5,5,5	0.53	0	5,5,5	0.67	0
4	GOL	D	276	-	5,5,5	0.28	0	5,5,5	0.99	0
4	GOL	A	276	-	5,5,5	0.32	0	5,5,5	0.63	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
4	GOL	B	100	-	-	0/4/4/4	-
4	GOL	A	277	-	-	2/4/4/4	-
4	GOL	D	277	-	-	0/4/4/4	-
4	GOL	A	278	-	-	1/4/4/4	-
4	GOL	D	276	-	-	0/4/4/4	-
4	GOL	A	276	-	-	0/4/4/4	-

There are no bond length outliers.

All (1) bond angle outliers are listed below:

Mol	Chain	Res	Type	Atoms	Z	Observed(°)	Ideal(°)
4	B	100	GOL	C3-C2-C1	-3.93	97.37	111.80

There are no chirality outliers.

All (3) torsion outliers are listed below:

Mol	Chain	Res	Type	Atoms
4	A	277	GOL	C1-C2-C3-O3
4	A	277	GOL	O2-C2-C3-O3
4	A	278	GOL	O2-C2-C3-O3

There are no ring outliers.

3 monomers are involved in 3 short contacts:

Mol	Chain	Res	Type	Clashes	Symm-Clashes
4	A	277	GOL	1	0
4	A	278	GOL	1	0
4	D	276	GOL	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 [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	275/275 (100%)	-0.03	7 (2%) 58 62	11, 22, 36, 55	15 (5%)
1	D	275/275 (100%)	-0.01	4 (1%) 71 75	11, 23, 39, 45	8 (2%)
2	B	100/100 (100%)	-0.11	1 (1%) 79 82	11, 22, 38, 45	6 (6%)
2	E	100/100 (100%)	-0.10	1 (1%) 79 82	11, 22, 36, 45	4 (4%)
3	C	9/9 (100%)	0.65	1 (11%) 12 11	20, 22, 35, 39	0
3	F	9/9 (100%)	0.08	0 100 100	15, 24, 32, 33	1 (11%)
All	All	768/768 (100%)	-0.03	14 (1%) 67 71	11, 22, 37, 55	34 (4%)

The worst 5 of 14 RSRZ outliers are listed below:

Mol	Chain	Res	Type	RSRZ
2	B	48[A]	LYS	4.0
1	A	90[A]	ALA	3.5
1	A	113	TYR	3.0
1	D	107	TRP	3.0
1	A	17	ARG	2.7

### 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
4	GOL	B	100	6/6	0.71	0.14	39,43,45,46	0
4	GOL	A	277	6/6	0.73	0.19	42,42,44,45	0
4	GOL	A	278	6/6	0.74	0.35	41,42,42,43	6
4	GOL	D	276	6/6	0.77	0.16	36,40,41,44	0
4	GOL	D	277	6/6	0.91	0.16	26,29,32,36	0
4	GOL	A	276	6/6	0.95	0.09	26,27,28,29	0
5	NA	E	100	1/1	0.95	0.11	33,33,33,33	1
5	NA	B	101	1/1	0.96	0.13	30,30,30,30	0

## 6.5 Other polymers [i](#)

There are no such residues in this entry.