



Full wwPDB X-ray Structure Validation Report ⓘ

Mar 9, 2026 – 01:43 PM UTC

PDB ID : 7U21 / pdb_00007u21
Title : Human Class I MHC HLA-A2 in complex with AVGSYVYSV peptide
Authors : Weiss, L.I.; Baker, B.M.
Deposited on : 2022-02-22
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

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	:	20250101.v01 (using entries in the PDB archive January 1st 2025)
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)	:	2.49

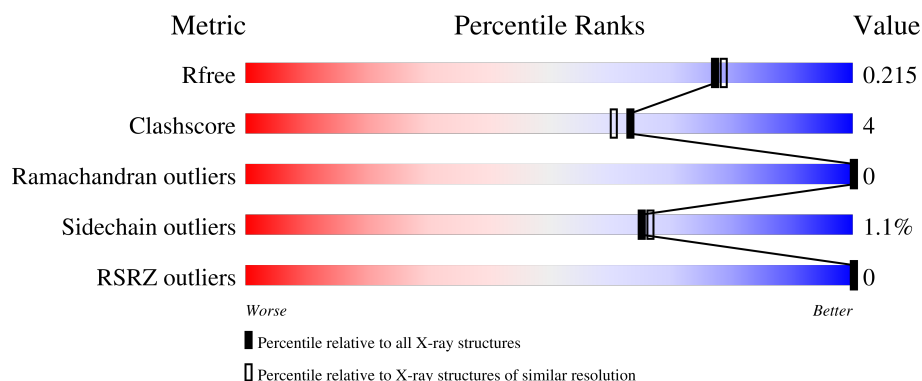
1 Overall quality at a glance

The following experimental techniques were used to determine the structure:

X-RAY DIFFRACTION

The reported resolution of this entry is 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}	180053	7789 (1.90-1.90)
Clashscore	190562	8410 (1.90-1.90)
Ramachandran outliers	187476	8333 (1.90-1.90)
Sidechain outliers	187428	8333 (1.90-1.90)
RSRZ outliers	180081	7790 (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 ≥ 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	92% 8%
1	D	275	88% 12%
2	B	100	90% 10%
2	E	100	92% 8%
3	C	9	100%

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Mol	Chain	Length	Quality of chain
3	F	9	 78% 22%

2 Entry composition [i](#)

There are 4 unique types of molecules in this entry. The entry contains 7044 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 MHC class I antigen, A-2 alpha chain.

Mol	Chain	Residues	Atoms					ZeroOcc	AltConf	Trace
1	A	275	Total	C	N	O	S	0	0	0
			2247	1403	409	426	9			
1	D	275	Total	C	N	O	S	0	0	0
			2247	1403	409	426	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	0	0
			837	533	141	159	4			
2	E	100	Total	C	N	O	S	0	0	0
			837	533	141	159	4			

There are 2 discrepancies between the modelled and reference sequences:

Chain	Residue	Modelled	Actual	Comment	Reference
B	1	MET	-	initiating methionine	UNP P61769
E	1	MET	-	initiating methionine	UNP P61769

- Molecule 3 is a protein called PGM5 peptide (465-473) (H5Y).

Mol	Chain	Residues	Atoms				ZeroOcc	AltConf	Trace
3	C	9	Total	C	N	O	0	0	0
			67	44	9	14			
3	F	9	Total	C	N	O	0	0	0
			67	44	9	14			

- Molecule 4 is water.

Mol	Chain	Residues	Atoms		ZeroOcc	AltConf
4	A	250	Total	O	0	0
			250	250		

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Mol	Chain	Residues	Atoms		ZeroOcc	AltConf
4	B	107	Total 107	O 107	0	0
4	C	9	Total 9	O 9	0	0
4	D	246	Total 246	O 246	0	0
4	E	122	Total 122	O 122	0	0
4	F	8	Total 8	O 8	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.

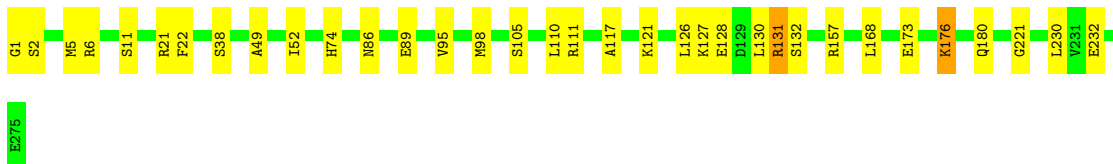
- Molecule 1: MHC class I antigen, A-2 alpha chain

Chain A:  92% 8%



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

Chain D:  88% 12%



- Molecule 2: Beta-2-microglobulin

Chain B:  90% 10%

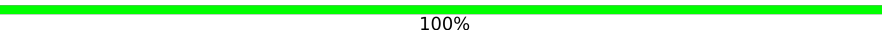


- Molecule 2: Beta-2-microglobulin

Chain E:  92% 8%



- Molecule 3: PGM5 peptide (465-473) (H5Y)

Chain C:  100%

There are no outlier residues recorded for this chain.

- Molecule 3: PGM5 peptide (465-473) (H5Y)

Chain F:  78% 22%



4 Data and refinement statistics

Property	Value	Source
Space group	P 1 21 1	Depositor
Cell constants a, b, c, α , β , γ	58.48Å 84.65Å 84.32Å 90.00° 90.00° 90.00°	Depositor
Resolution (Å)	48.05 – 1.90 48.05 – 1.90	Depositor EDS
% Data completeness (in resolution range)	93.3 (48.05-1.90) 93.4 (48.05-1.90)	Depositor EDS
R_{merge}	0.05	Depositor
R_{sym}	(Not available)	Depositor
$\langle I/\sigma(I) \rangle$ ¹	1.94 (at 1.90Å)	Xtriage
Refinement program	PHENIX 1.20rc3_4406	Depositor
R, R_{free}	0.193 , 0.214 0.193 , 0.215	Depositor DCC
R_{free} test set	6185 reflections (10.05%)	wwPDB-VP
Wilson B-factor (Å ²)	16.0	Xtriage
Anisotropy	0.745	Xtriage
Bulk solvent k_{sol} (e/Å ³), B_{sol} (Å ²)	0.34 , 24.2	EDS
L-test for twinning ²	$\langle L \rangle = 0.47$, $\langle L^2 \rangle = 0.30$	Xtriage
Estimated twinning fraction	0.029 for -h,-l,-k 0.024 for -h,l,k 0.248 for h,-k,-l	Xtriage
F_o, F_c correlation	0.97	EDS
Total number of atoms	7044	wwPDB-VP
Average B, all atoms (Å ²)	22.0	wwPDB-VP

Xtriage's analysis on translational NCS is as follows: *The largest off-origin peak in the Patterson function is 10.16% of the height of the origin peak. No significant pseudotranslation is detected.*

¹Intensities estimated from amplitudes.

²Theoretical 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](#)

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	0.34	0/2312	0.58	0/3137
1	D	0.34	0/2312	0.56	1/3137 (0.0%)
2	B	0.39	0/860	0.65	0/1162
2	E	0.28	0/860	0.50	0/1162
3	C	0.79	0/68	0.88	0/91
3	F	0.80	0/68	0.94	0/91
All	All	0.35	0/6480	0.58	1/8780 (0.0%)

There are no bond length outliers.

All (1) bond angle outliers are listed below:

Mol	Chain	Res	Type	Atoms	Z	Observed(°)	Ideal(°)
1	D	110	LEU	N-CA-C	-5.12	106.13	112.93

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	2247	0	2096	17	2
1	D	2247	0	2096	20	1
2	B	837	0	803	6	1
2	E	837	0	803	10	1
3	C	67	0	65	0	0
3	F	67	0	65	0	0

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Mol	Chain	Non-H	H(model)	H(added)	Clashes	Symm-Clashes
4	A	250	0	0	7	2
4	B	107	0	0	1	0
4	C	9	0	0	0	0
4	D	246	0	0	2	0
4	E	122	0	0	7	1
4	F	8	0	0	0	0
All	All	7044	0	5928	49	5

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 4.

All (49) 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:232:GLU:HG3	4:E:212:HOH:O	1.64	0.96
1:A:35:ARG:NE	4:A:305:HOH:O	2.34	0.61
1:D:176:LYS:HA	1:D:180:GLN:HG3	1.87	0.57
2:E:35:ASP:OD1	4:E:201:HOH:O	2.18	0.55
2:E:76:LYS:NZ	4:E:204:HOH:O	2.39	0.55
1:A:106:ASP:OD2	1:A:108:ARG:HD3	2.09	0.53
1:D:22:PHE:HB3	1:D:38:SER:HB3	1.90	0.53
2:B:40:LEU:HD23	2:B:69:THR:HG22	1.91	0.53
1:A:82:ARG:NH1	1:A:89:GLU:HB2	2.26	0.50
1:D:89:GLU:HG2	1:D:89:GLU:O	2.11	0.50
1:D:5:MET:HB2	1:D:168:LEU:HD13	1.94	0.49
2:E:20:LYS:HD3	4:E:266:HOH:O	2.13	0.49
2:B:7:LYS:N	2:B:7:LYS:HD3	2.27	0.48
1:D:131:ARG:HG2	1:D:157:ARG:NH1	2.28	0.48
1:A:197:HIS:HB2	4:A:315:HOH:O	2.12	0.48
1:D:230:LEU:HD21	4:D:453:HOH:O	2.15	0.47
1:A:44:ARG:NH1	4:A:318:HOH:O	2.48	0.46
1:D:1:GLY:O	1:D:105:SER:HA	2.16	0.46
1:D:131:ARG:HG2	1:D:157:ARG:HH11	1.79	0.46
1:A:189:MET:HE3	1:A:274:TRP:CE2	2.51	0.46
1:D:121:LYS:HG2	2:E:2:ILE:HD12	1.15	0.46
1:A:117:ALA:HB2	2:B:61:TRP:CE2	2.51	0.46
1:A:176:LYS:HE3	4:A:482:HOH:O	2.16	0.46
1:A:82:ARG:HH12	1:A:89:GLU:HB2	1.80	0.45
2:E:20:LYS:HE2	4:E:203:HOH:O	2.16	0.45
1:D:126:LEU:HG	1:D:130:LEU:HA	1.98	0.45
2:E:20:LYS:CE	4:E:203:HOH:O	2.65	0.45

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Atom-1	Atom-2	Interatomic distance (Å)	Clash overlap (Å)
2:E:20:LYS:NZ	4:E:203:HOH:O	2.30	0.44
1:D:49:ALA:O	1:D:52:ILE:HG22	2.17	0.44
1:A:131:ARG:NH2	1:D:221:GLY:O	2.40	0.44
2:B:96:TRP:CH2	2:B:98:ARG:HD2	2.52	0.44
1:D:11:SER:HA	1:D:21:ARG:O	2.19	0.43
2:E:1:MET:HE3	2:E:1:MET:HB2	1.66	0.43
1:A:264:GLU:HG2	4:A:364:HOH:O	2.20	0.42
2:B:23:PHE:CZ	2:B:70:GLU:HG3	2.54	0.42
1:A:232:GLU:HG3	4:B:210:HOH:O	2.18	0.42
1:D:6:ARG:HD3	1:D:98:MET:HE2	2.02	0.42
1:D:117:ALA:HB2	2:E:61:TRP:CE2	2.54	0.42
2:B:23:PHE:CE1	2:B:70:GLU:HG3	2.56	0.41
1:A:81:LEU:HD13	1:A:118:TYR:CD1	2.56	0.41
1:A:11:SER:HA	1:A:21:ARG:O	2.20	0.41
1:D:127:LYS:HD2	1:D:132:SER:OG	2.21	0.41
1:A:18:GLY:N	4:A:302:HOH:O	2.02	0.41
1:D:86:ASN:ND2	4:D:317:HOH:O	2.52	0.41
1:A:82:ARG:HE	1:A:82:ARG:HB3	1.65	0.40
1:D:74:HIS:HD1	1:D:95:VAL:CG1	2.34	0.40
1:D:111:ARG:NH2	1:D:128:GLU:OE2	2.50	0.40
1:A:204:TRP:HH2	4:A:341:HOH:O	2.04	0.40
2:E:7:LYS:N	2:E:7:LYS:HD3	2.36	0.40

All (5) 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:A:17:ARG:CD	2:E:90:GLN:NE2[1_565]	1.63	0.57
4:A:426:HOH:O	4:A:469:HOH:O[1_655]	1.87	0.33
1:A:82:ARG:NH2	2:B:75:GLU:OE2[1_655]	1.96	0.24
1:D:173:GLU:OE1	4:E:204:HOH:O[2_656]	2.04	0.16
4:A:475:HOH:O	4:A:506:HOH:O[1_655]	2.18	0.02

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	273/275 (99%)	266 (97%)	7 (3%)	0	100	100
1	D	273/275 (99%)	265 (97%)	8 (3%)	0	100	100
2	B	98/100 (98%)	98 (100%)	0	0	100	100
2	E	98/100 (98%)	96 (98%)	2 (2%)	0	100	100
3	C	7/9 (78%)	7 (100%)	0	0	100	100
3	F	7/9 (78%)	7 (100%)	0	0	100	100
All	All	756/768 (98%)	739 (98%)	17 (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	231/231 (100%)	230 (100%)	1 (0%)	84	87
1	D	231/231 (100%)	228 (99%)	3 (1%)	61	61
2	B	95/95 (100%)	94 (99%)	1 (1%)	65	67
2	E	95/95 (100%)	95 (100%)	0	100	100
3	C	7/7 (100%)	7 (100%)	0	100	100
3	F	7/7 (100%)	5 (71%)	2 (29%)	0	0
All	All	666/666 (100%)	659 (99%)	7 (1%)	65	67

All (7) residues with a non-rotameric sidechain are listed below:

Mol	Chain	Res	Type
1	A	42	SER
2	B	1	MET
1	D	2	SER
1	D	131	ARG

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Mol	Chain	Res	Type
1	D	176	LYS
3	F	5	TYR
3	F	6	VAL

Sometimes sidechains can be flipped to improve hydrogen bonding and reduce clashes. All (10) such sidechains are listed below:

Mol	Chain	Res	Type
1	A	43	GLN
1	A	54	GLN
1	A	145	HIS
1	A	151	HIS
1	A	155	GLN
1	A	180	GLN
2	B	14	HIS
2	B	52	HIS
1	D	54	GLN
1	D	145	HIS

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](#)

There are no ligands in this entry.

5.7 Other polymers [i](#)

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, 95th 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 ²)	Q<0.9
1	A	275/275 (100%)	-1.45	0 100 100	13, 20, 36, 49	0
1	D	275/275 (100%)	-1.46	0 100 100	12, 20, 37, 65	0
2	B	100/100 (100%)	-1.50	0 100 100	13, 20, 31, 52	0
2	E	100/100 (100%)	-1.48	0 100 100	13, 19, 33, 51	0
3	C	9/9 (100%)	-1.24	0 100 100	15, 21, 30, 43	0
3	F	9/9 (100%)	-1.17	0 100 100	18, 22, 34, 54	0
All	All	768/768 (100%)	-1.46	0 100 100	12, 20, 36, 65	0

There are no RSRZ outliers to report.

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.