



Full wwPDB X-ray Structure Validation Report ⓘ

Mar 9, 2026 – 02:49 AM UTC

PDB ID : 5Y91 / pdb_00005y91
Title : The structure of the MHC class I molecule of bony fishes provides insights into the conserved nature of the antigen-presenting system
Authors : Zhaosan, C.; Nianzhi, Z.; Chun, X.
Deposited on : 2017-08-22
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

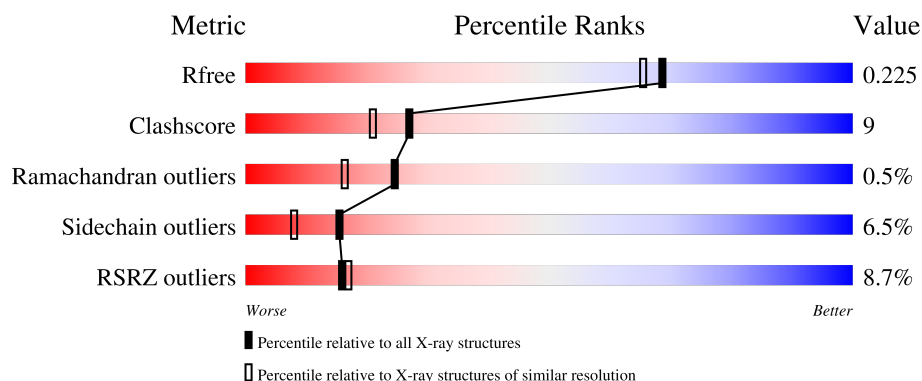
1 Overall quality at a glance

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	10% 79% 16% ...
2	B	116	3% 66% 16% • 16%
3	C	9	11% 56% 33% 11%

2 Entry composition

There are 4 unique types of molecules in this entry. The entry contains 3401 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.

Mol	Chain	Residues	Atoms					ZeroOcc	AltConf	Trace
1	A	273	Total	C	N	O	S	0	1	0
			2203	1387	371	435	10			

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

Mol	Chain	Residues	Atoms					ZeroOcc	AltConf	Trace
2	B	97	Total	C	N	O	S	0	0	0
			782	500	128	150	4			

- Molecule 3 is a protein called PEPTIDE PHE-ALA-ASN-PHE-CYS-LEU-MET-MET-ILE.

Mol	Chain	Residues	Atoms					ZeroOcc	AltConf	Trace
3	C	9	Total	C	N	O	S	0	0	0
			74	50	10	11	3			

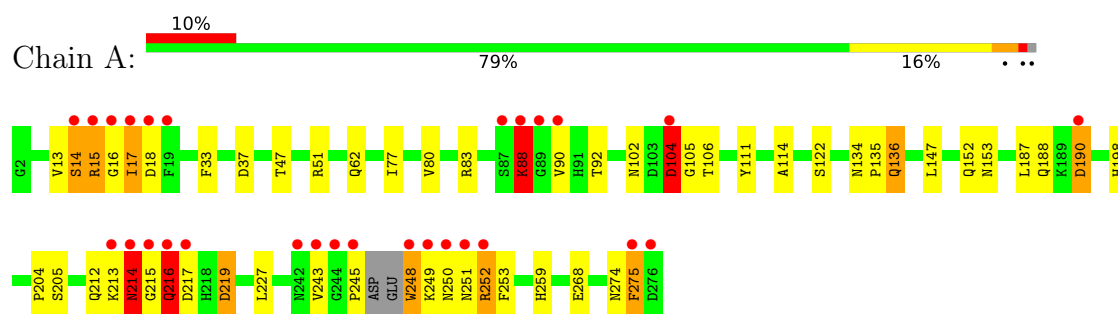
- Molecule 4 is water.

Mol	Chain	Residues	Atoms		ZeroOcc	AltConf
4	A	242	Total	O	0	0
			242	242		
4	B	96	Total	O	0	0
			96	96		
4	C	4	Total	O	0	0
			4	4		

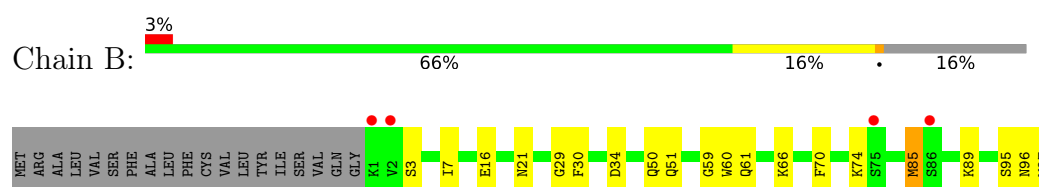
3 Residue-property plots [i](#)

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



- Molecule 2: Beta-2-microglobulin



- Molecule 3: PEPTIDE PHE-ALA-ASN-PHE-CYS-LEU-MET-MET-ILE



4 Data and refinement statistics

Property	Value	Source
Space group	C 1 2 1	Depositor
Cell constants a, b, c, α , β , γ	119.28Å 50.41Å 86.08Å 90.00° 124.08° 90.00°	Depositor
Resolution (Å)	32.88 – 1.90 32.88 – 1.90	Depositor EDS
% Data completeness (in resolution range)	94.7 (32.88-1.90) 99.0 (32.88-1.90)	Depositor EDS
R_{merge}	(Not available)	Depositor
R_{sym}	(Not available)	Depositor
$\langle I/\sigma(I) \rangle$ ¹	2.70 (at 1.91Å)	Xtriage
Refinement program	PHENIX 1.5_2	Depositor
R, R_{free}	0.190 , 0.224 0.193 , 0.225	Depositor DCC
R_{free} test set	1689 reflections (5.02%)	wwPDB-VP
Wilson B-factor (Å ²)	22.3	Xtriage
Anisotropy	0.303	Xtriage
Bulk solvent k_{sol} (e/Å ³), B_{sol} (Å ²)	0.35 , 41.4	EDS
L-test for twinning ²	$\langle L \rangle = 0.49$, $\langle L^2 \rangle = 0.32$	Xtriage
Estimated twinning fraction	No twinning to report.	Xtriage
F_o, F_c correlation	0.95	EDS
Total number of atoms	3401	wwPDB-VP
Average B, all atoms (Å ²)	28.0	wwPDB-VP

Xtriage's analysis on translational NCS is as follows: *The largest off-origin peak in the Patterson function is 6.76% 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

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	0.41	1/2257 (0.0%)	0.79	9/3063 (0.3%)
2	B	0.25	0/803	0.71	0/1082
3	C	0.19	0/75	0.51	0/97
All	All	0.37	1/3135 (0.0%)	0.76	9/4242 (0.2%)

Chiral center outliers are detected by calculating the chiral volume of a chiral center and verifying if the center is modelled as a planar moiety or with the opposite hand. A planarity outlier is detected by checking planarity of atoms in a peptide group, atoms in a mainchain group or atoms of a sidechain that are expected to be planar.

Mol	Chain	#Chirality outliers	#Planarity outliers
1	A	0	1

All (1) bond length outliers are listed below:

Mol	Chain	Res	Type	Atoms	Z	Observed(Å)	Ideal(Å)
1	A	13	VAL	C-O	-6.51	1.17	1.24

All (9) bond angle outliers are listed below:

Mol	Chain	Res	Type	Atoms	Z	Observed(°)	Ideal(°)
1	A	88	LYS	CB-CA-C	9.53	129.39	110.42
1	A	216	GLN	N-CA-C	-8.58	97.53	110.14
1	A	214	ASN	CB-CA-C	-7.20	96.09	110.42
1	A	214	ASN	CA-C-N	-7.14	111.85	121.27
1	A	214	ASN	C-N-CA	-7.14	111.85	121.27
1	A	105	GLY	N-CA-C	-6.32	106.71	114.92
1	A	248	TRP	CA-C-N	6.13	130.81	120.88
1	A	248	TRP	C-N-CA	6.13	130.81	120.88
1	A	214	ASN	N-CA-C	5.42	122.33	110.80

There are no chirality outliers.

All (1) planarity outliers are listed below:

Mol	Chain	Res	Type	Group
1	A	214	ASN	Peptide

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	2203	0	2070	46	0
2	B	782	0	764	11	0
3	C	74	0	76	3	0
4	A	242	0	0	7	0
4	B	96	0	0	0	0
4	C	4	0	0	0	0
All	All	3401	0	2910	55	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 9.

All (55) 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:248:TRP:O	4:A:301:HOH:O	1.83	0.95
1:A:213:LYS:HG2	1:A:214:ASN:HD22	1.48	0.79
2:B:29:GLY:HA2	2:B:61:GLN:HB3	1.65	0.78
1:A:212:GLN:HG2	1:A:217:ASP:HA	1.66	0.77
2:B:85:MET:HA	2:B:85:MET:HE2	1.72	0.72
1:A:214:ASN:N	1:A:215:GLY:HA3	2.05	0.71
1:A:213:LYS:C	1:A:215:GLY:HA3	2.16	0.71
1:A:62:GLN:HE22	3:C:2:ALA:HB3	1.56	0.69
1:A:213:LYS:O	1:A:214:ASN:HB2	1.91	0.69
1:A:214:ASN:HD21	1:A:251:ASN:HB3	1.58	0.69
2:B:16:GLU:HG2	2:B:97:MET:HE1	1.81	0.62
1:A:152:GLN:HE22	3:C:3:ASN:HD21	1.48	0.61
1:A:147:LEU:HD13	3:C:7:MET:SD	2.40	0.61
1:A:214:ASN:N	1:A:215:GLY:CA	2.64	0.60
1:A:104:ASP:HB3	1:A:106:THR:H	1.66	0.60

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Atom-1	Atom-2	Interatomic distance (Å)	Clash overlap (Å)
1:A:213:LYS:HG2	1:A:214:ASN:ND2	2.16	0.60
1:A:136:GLN:NE2	1:A:136:GLN:H	2.00	0.60
1:A:259:HIS:HD2	4:A:332:HOH:O	1.85	0.59
1:A:205:SER:HB2	1:A:227:LEU:HD21	1.87	0.56
1:A:15:ARG:NH2	1:A:88:LYS:O	2.39	0.55
1:A:14:SER:O	1:A:15:ARG:HG2	2.07	0.55
1:A:213:LYS:C	1:A:215:GLY:CA	2.79	0.55
1:A:122:SER:HB2	4:A:483:HOH:O	2.08	0.54
1:A:114:ALA:HB2	2:B:60:TRP:CE2	2.44	0.53
1:A:33:PHE:HA	1:A:47:THR:HG23	1.92	0.50
2:B:7:ILE:HD12	2:B:89:LYS:HE3	1.94	0.49
1:A:16:GLY:HA3	1:A:17:ILE:HA	1.63	0.48
1:A:51:ARG:HA	4:A:335:HOH:O	2.13	0.47
2:B:51:GLN:HE21	2:B:66:LYS:HD2	1.79	0.47
1:A:198:HIS:HD2	4:A:341:HOH:O	1.96	0.47
1:A:213:LYS:O	1:A:215:GLY:HA2	2.15	0.47
1:A:104:ASP:HB3	1:A:106:THR:HG23	1.97	0.47
1:A:204:PRO:O	1:A:259:HIS:HE1	1.99	0.46
1:A:102:ASN:HB2	1:A:104:ASP:HB2	1.98	0.46
1:A:152:GLN:NE2	1:A:153:ASN:HD22	2.14	0.46
1:A:77:ILE:HA	1:A:80:VAL:HG12	1.98	0.46
1:A:252:ARG:HG2	4:A:518:HOH:O	2.16	0.46
1:A:37:ASP:OD2	1:A:37:ASP:C	2.59	0.45
1:A:14:SER:C	1:A:15:ARG:HG2	2.42	0.45
1:A:214:ASN:ND2	1:A:251:ASN:HB3	2.30	0.45
1:A:274:ASN:HA	1:A:275:PHE:HA	1.74	0.45
1:A:134:ASN:HB2	1:A:135:PRO:HD2	2.00	0.43
1:A:216:GLN:H	1:A:216:GLN:HG2	1.48	0.43
1:A:212:GLN:HG2	1:A:217:ASP:CA	2.41	0.43
1:A:213:LYS:HB2	1:A:253:PHE:CE2	2.54	0.42
1:A:245:PRO:O	1:A:249:LYS:HB3	2.18	0.42
1:A:219:ASP:O	1:A:219:ASP:CG	2.63	0.42
2:B:59:GLY:O	2:B:60:TRP:HB2	2.19	0.42
1:A:268:GLU:HG2	4:A:376:HOH:O	2.19	0.42
1:A:136:GLN:H	1:A:136:GLN:HE21	1.67	0.41
2:B:95:SER:O	2:B:96:ASN:HB2	2.20	0.41
1:A:188:GLN:HG2	1:A:190:ASP:O	2.21	0.41
2:B:3:SER:O	2:B:30:PHE:HA	2.21	0.41
2:B:21:ASN:HB3	2:B:70:PHE:CE1	2.55	0.41
1:A:18:ASP:HB2	2:B:34:ASP:OD2	2.20	0.41

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	270/275 (98%)	261 (97%)	7 (3%)	2 (1%)	18	10
2	B	95/116 (82%)	92 (97%)	3 (3%)	0	100	100
3	C	7/9 (78%)	7 (100%)	0	0	100	100
All	All	372/400 (93%)	360 (97%)	10 (3%)	2 (0%)	24	16

All (2) Ramachandran outliers are listed below:

Mol	Chain	Res	Type
1	A	88	LYS
1	A	104	ASP

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	241/242 (100%)	224 (93%)	17 (7%)	13	7
2	B	89/105 (85%)	86 (97%)	3 (3%)	32	25
3	C	8/8 (100%)	6 (75%)	2 (25%)	0	0
All	All	338/355 (95%)	316 (94%)	22 (6%)	15	8

All (22) residues with a non-rotameric sidechain are listed below:

Mol	Chain	Res	Type
1	A	14	SER

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Mol	Chain	Res	Type
1	A	15	ARG
1	A	17	ILE
1	A	83	ARG
1	A	90	VAL
1	A	92	THR
1	A	104	ASP
1	A	111	TYR
1	A	136	GLN
1	A	187	LEU
1	A	190	ASP
1	A	216	GLN
1	A	219	ASP
1	A	243	VAL
1	A	250	ASN
1	A	252	ARG
1	A	275	PHE
2	B	50	GLN
2	B	74	LYS
2	B	85	MET
3	C	4	PHE
3	C	7	MET

Sometimes sidechains can be flipped to improve hydrogen bonding and reduce clashes. All (18) such sidechains are listed below:

Mol	Chain	Res	Type
1	A	32	GLN
1	A	64	GLN
1	A	71	GLN
1	A	86	GLN
1	A	102	ASN
1	A	136	GLN
1	A	152	GLN
1	A	153	ASN
1	A	183	GLN
1	A	198	HIS
1	A	214	ASN
1	A	216	GLN
1	A	250	ASN
1	A	259	HIS
2	B	50	GLN
2	B	51	GLN
2	B	61	GLN

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Mol	Chain	Res	Type
2	B	63	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 [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, 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	273/275 (99%)	0.38	28 (10%) 12 12	10, 24, 60, 74	1 (0%)
2	B	97/116 (83%)	0.15	4 (4%) 41 44	15, 24, 39, 66	0
3	C	9/9 (100%)	0.98	1 (11%) 10 11	17, 28, 35, 40	0
All	All	379/400 (94%)	0.33	33 (8%) 16 17	10, 24, 55, 74	1 (0%)

All (33) RSRZ outliers are listed below:

Mol	Chain	Res	Type	RSRZ
1	A	88	LYS	5.2
1	A	248	TRP	4.9
1	A	276	ASP	4.7
1	A	275	PHE	4.3
1	A	17	ILE	4.1
1	A	89	GLY	3.9
1	A	90	VAL	3.9
1	A	243	VAL	3.7
3	C	4	PHE	3.7
1	A	244	GLY	3.7
1	A	190	ASP	3.6
2	B	2	VAL	3.4
1	A	213	LYS	3.3
1	A	16	GLY	3.3
1	A	242	ASN	3.3
1	A	87	SER	3.3
1	A	15	ARG	3.2
1	A	217	ASP	3.1
1	A	14	SER	3.0
1	A	104	ASP	3.0
1	A	18	ASP	3.0
1	A	214	ASN	3.0
1	A	215	GLY	2.9

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Mol	Chain	Res	Type	RSRZ
1	A	245	PRO	2.9
1	A	250	ASN	2.9
2	B	1	LYS	2.6
1	A	252	ARG	2.6
1	A	216	GLN	2.6
1	A	249	LYS	2.5
2	B	75	SER	2.4
1	A	251	ASN	2.3
1	A	19	PHE	2.2
2	B	86	SER	2.2

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.