WORLDWIDE wwPDB PROTEIN DATA BANK

Full wwPDB X-ray Structure Validation Report (i)

Dec 15, 2025 – 10:38 PM JST

PDB ID	:	9L4I / pdb_00009l4i
Title	:	Crystal structure of HLA-C*14:02 complexed with KIR2DL2
Authors	:	Liu, Q.Y.; Yang, M.; Wei, P.C.
Deposited on	:	2024-12-20
Resolution	:	2.50 Å(reported)

The following versions of software and data (see references (i)) 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)	:	2.47

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 2.50 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.
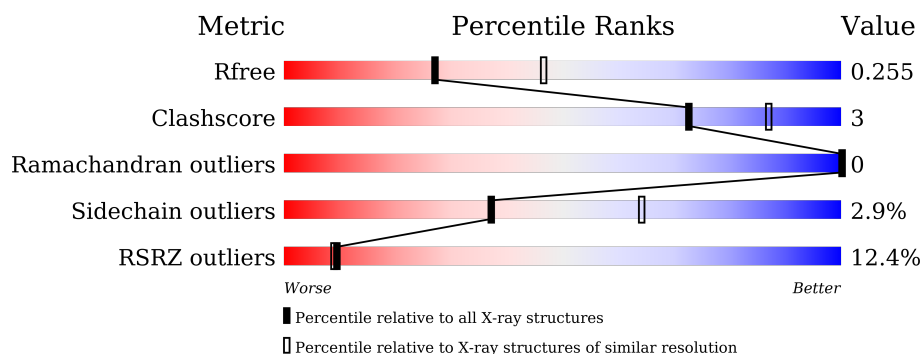
Metric	Whole archive (#Entries)	Similar resolution (#Entries, resolution range(Å))
R_{free}	164625	5504 (2.50-2.50)
Clashscore	180529	6282 (2.50-2.50)
Ramachandran outliers	177936	6191 (2.50-2.50)
Sidechain outliers	177891	6193 (2.50-2.50)
RSRZ outliers	164620	5504 (2.50-2.50)

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 <=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	273	13% 93% 5% ·
2	B	100	9% 84% 14% ·
3	C	8	88% 12%
4	D	196	13% 82% 10% · 7%

2 Entry composition ⓘ

There are 5 unique types of molecules in this entry. The entry contains 4680 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	268	Total	C	N	O	S	0	1	0
			2197	1368	402	421	6			

- 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			

There is a discrepancy between the modelled and reference sequences:

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

- Molecule 3 is a protein called LL8.

Mol	Chain	Residues	Atoms				ZeroOcc	AltConf	Trace
3	C	8	Total	C	N	O	0	0	0
			63	41	9	13			

- Molecule 4 is a protein called Killer cell immunoglobulin-like receptor 2DL2.

Mol	Chain	Residues	Atoms					ZeroOcc	AltConf	Trace
4	D	182	Total	C	N	O	S	0	0	0
			1419	900	242	269	8			

There is a discrepancy between the modelled and reference sequences:

Chain	Residue	Modelled	Actual	Comment	Reference
D	141	LEU	ARG	conflict	UNP P43627

- Molecule 5 is water.

Mol	Chain	Residues	Atoms		ZeroOcc	AltConf
5	A	87	Total 87	O 87	0	0
5	B	26	Total 26	O 26	0	0
5	C	9	Total 9	O 9	0	0
5	D	42	Total 42	O 42	0	0

3 Residue-property plots ⓘ

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.
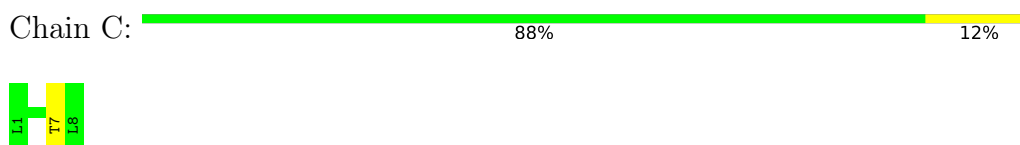
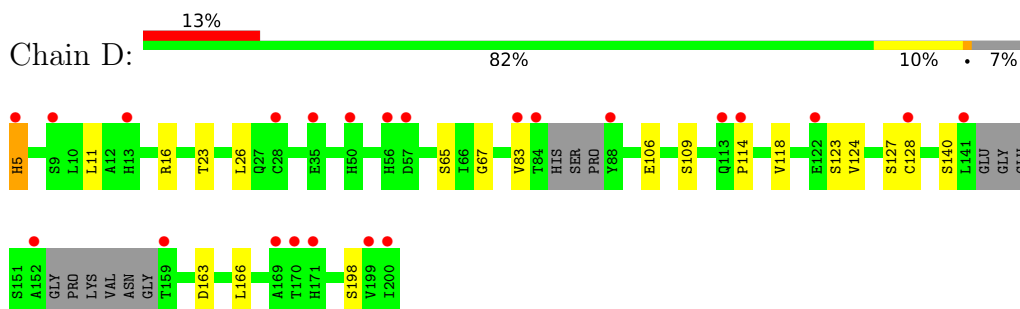• Molecule 1: MHC class I antigen

Chain A:
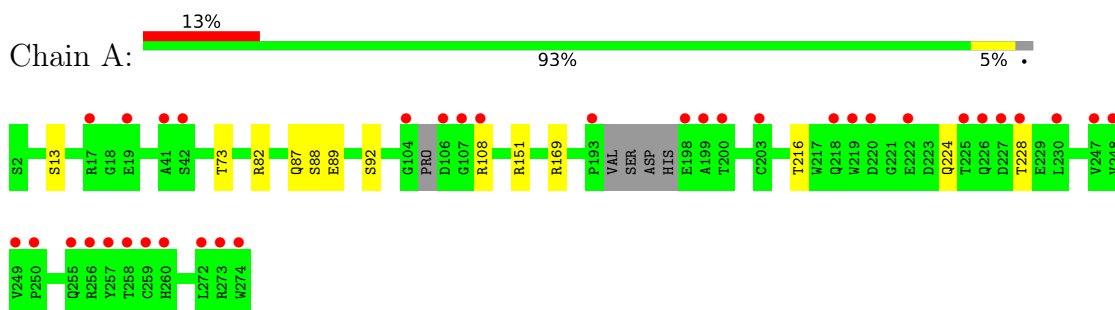
• Molecule 2: Beta-2-microglobulin

Chain B:

• Molecule 3: LL8

Chain C:
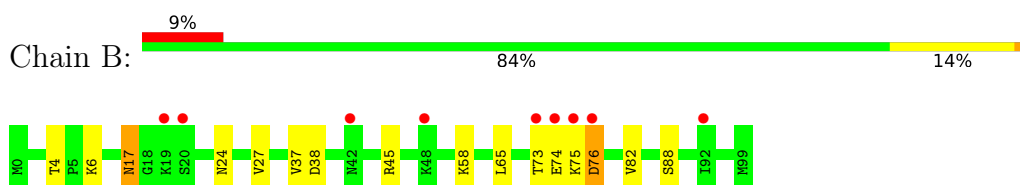
• Molecule 4: Killer cell immunoglobulin-like receptor 2DL2

Chain D:

4 Data and refinement statistics ⓘ

Property	Value	Source
Space group	I 2 2 2	Depositor
Cell constants a, b, c, α, β, γ	83.95Å 160.15Å 177.61Å 90.00° 90.00° 90.00°	Depositor
Resolution (Å)	45.05 – 2.50 45.05 – 2.50	Depositor EDS
% Data completeness (in resolution range)	99.9 (45.05-2.50) 99.9 (45.05-2.50)	Depositor EDS
R_{merge}	0.03	Depositor
R_{sym}	(Not available)	Depositor
$< I/\sigma(I) >$ [1]	3.65 (at 2.51Å)	Xtriage
Refinement program	PHENIX 1.20.1_4487, PHENIX 1.20.1_4487	Depositor
R, R_{free}	0.230 , 0.253 0.231 , 0.255	Depositor DCC
R_{free} test set	2000 reflections (4.78%)	wwPDB-VP
Wilson B-factor (Å^2)	44.5	Xtriage
Anisotropy	0.272	Xtriage
Bulk solvent k_{sol}(e/Å^3), B_{sol}(Å^2)	0.35 , 53.6	EDS
L-test for twinning[2]	$< |L| > = 0.49, < L^2 > = 0.32$	Xtriage
Estimated twinning fraction	No twinning to report.	Xtriage
F_o, F_c correlation	0.93	EDS
Total number of atoms	4680	wwPDB-VP
Average B, all atoms (Å^2)	48.0	wwPDB-VP

Xtriage's analysis on translational NCS is as follows: *The largest off-origin peak in the Patterson function is 4.86% of the height of the origin peak. No significant pseudotranslation is detected.*

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[1]Intensities estimated from amplitudes.

[2]Theoretical values of $< |L| >$, $< L^2 >$ 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	0.23	0/2257	0.32	0/3064
2	B	0.25	0/860	0.45	1/1162 (0.1%)
3	C	0.11	0/63	0.33	0/85
4	D	0.12	0/1457	0.32	0/1974
All	All	0.20	0/4637	0.35	1/6285 (0.0%)

There are no bond length outliers.

All (1) bond angle outliers are listed below:

Mol	Chain	Res	Type	Atoms	Z	Observed(^{o})	Ideal(^{o})
2	B	76	ASP	N-CA-C	-5.32	98.72	108.02

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	2197	0	2039	9	0
2	B	837	0	803	9	0
3	C	63	0	67	1	0
4	D	1419	0	1358	10	0
5	A	87	0	0	1	0
5	B	26	0	0	0	0
5	C	9	0	0	0	0
5	D	42	0	0	0	0

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Mol	Chain	Non-H	H(model)	H(added)	Clashes	Symm-Clashes
All	All	4680	0	4267	27	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 (27) 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:73:THR:HG23	3:C:7:THR:HG22	1.70	0.73
4:D:16:ARG:HH21	4:D:147:GLU:HG2	1.54	0.72
2:B:17:ASN:OD1	2:B:17:ASN:N	2.23	0.70
2:B:37:VAL:HG13	2:B:82:VAL:HG12	1.81	0.62
1:A:108:ARG:HG2	1:A:169:ARG:NH2	2.21	0.56
2:B:17:ASN:ND2	2:B:74:GLU:HG2	2.21	0.55
4:D:124:VAL:HG13	4:D:166:LEU:HB2	1.90	0.54
2:B:17:ASN:HB3	2:B:73:THR:HA	1.89	0.53
2:B:17:ASN:HD22	2:B:74:GLU:HG2	1.73	0.53
1:A:13:SER:O	1:A:92:SER:OG	2.24	0.51
4:D:127:SER:OG	4:D:163:ASP:OD1	2.25	0.50
4:D:140:SER:OG	4:D:147:GLU:OE2	2.31	0.49
4:D:114:PRO:HG3	4:D:124:VAL:HA	1.95	0.48
4:D:5:HIS:HD2	4:D:83:VAL:HG21	1.79	0.48
1:A:82:ARG:HG2	1:A:87:GLN:HB2	1.97	0.47
1:A:108:ARG:HG2	1:A:169:ARG:HH22	1.78	0.47
1:A:224:GLN:OE1	5:A:301:HOH:O	2.21	0.45
1:A:224:GLN:O	1:A:228:THR:HG23	2.16	0.45
4:D:23:THR:HG23	4:D:67:GLY:HA3	1.99	0.45
2:B:38:ASP:OD1	2:B:45:ARG:NH1	2.50	0.45
2:B:6:LYS:O	2:B:27:VAL:HA	2.17	0.44
2:B:58:LYS:HB3	2:B:58:LYS:HE3	1.59	0.43
2:B:24:ASN:HB3	2:B:65:LEU:HD11	2.01	0.42
4:D:114:PRO:CG	4:D:124:VAL:HA	2.50	0.41
4:D:109:SER:O	4:D:128:CYS:HA	2.20	0.41
1:A:82:ARG:CZ	1:A:89:GLU:HB3	2.51	0.41
1:A:151:ARG:NH2	4:D:106:GLU:OE1	2.54	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	262/273 (96%)	250 (95%)	12 (5%)	0	100	100
2	B	98/100 (98%)	93 (95%)	5 (5%)	0	100	100
3	C	6/8 (75%)	5 (83%)	1 (17%)	0	100	100
4	D	174/196 (89%)	170 (98%)	4 (2%)	0	100	100
All	All	540/577 (94%)	518 (96%)	22 (4%)	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	225/230 (98%)	223 (99%)	2 (1%)	75	90
2	B	95/95 (100%)	90 (95%)	5 (5%)	19	38
3	C	7/7 (100%)	7 (100%)	0	100	100
4	D	159/169 (94%)	152 (96%)	7 (4%)	24	47
All	All	486/501 (97%)	472 (97%)	14 (3%)	37	64

All (14) residues with a non-rotameric sidechain are listed below:

Mol	Chain	Res	Type
1	A	88	SER
1	A	216	THR

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Mol	Chain	Res	Type
2	B	4	THR
2	B	17	ASN
2	B	75	LYS
2	B	76	ASP
2	B	88	SER
4	D	5	HIS
4	D	11	LEU
4	D	26	LEU
4	D	65	SER
4	D	118	VAL
4	D	123	SER
4	D	198	SER

Sometimes sidechains can be flipped to improve hydrogen bonding and reduce clashes. All (2) such sidechains are listed below:

Mol	Chain	Res	Type
1	A	260	HIS
4	D	5	HIS

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 ⓘ

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(Å²)	Q<0.9
1	A	268/273 (98%)	0.47	35 (13%)	8	8	23, 41, 75, 87	0
2	B	100/100 (100%)	0.53	9 (9%)	17	15	24, 47, 77, 95	0
3	C	8/8 (100%)	-0.23	0	100	100	26, 29, 34, 36	0
4	D	182/196 (92%)	0.77	25 (13%)	8	7	32, 49, 74, 95	0
All	All	558/577 (96%)	0.57	69 (12%)	9	9	23, 46, 76, 95	0

All (69) RSRZ outliers are listed below:

Mol	Chain	Res	Type	RSRZ
4	D	113	GLN	4.8
4	D	84	THR	4.6
1	A	248	VAL	4.3
1	A	259	CYS	4.2
1	A	199	ALA	4.1
4	D	152	ALA	4.1
1	A	42	SER	4.0
1	A	225	THR	4.0
2	B	75	LYS	3.9
1	A	107	GLY	3.9
1	A	193	PRO	3.8
1	A	106	ASP	3.7
1	A	108	ARG	3.6
1	A	219	TRP	3.6
4	D	141	LEU	3.5
1	A	198	GLU	3.5
1	A	203	CYS	3.5
1	A	230	LEU	3.4
1	A	104	GLY	3.4
1	A	273	ARG	3.4
4	D	56	HIS	3.3

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Mol	Chain	Res	Type	RSRZ
4	D	171	HIS	3.3
1	A	200	THR	3.3
1	A	19	GLU	3.2
4	D	114	PRO	3.1
2	B	74	GLU	3.1
1	A	41	ALA	3.0
1	A	220	ASP	2.9
1	A	247	VAL	2.9
4	D	88	TYR	2.9
1	A	250	PRO	2.9
4	D	150	PHE	2.8
4	D	57	ASP	2.8
4	D	170	THR	2.8
2	B	48	LYS	2.8
1	A	227	ASP	2.7
1	A	274	TRP	2.6
2	B	92	ILE	2.6
4	D	128	CYS	2.6
1	A	249	VAL	2.6
1	A	255	GLN	2.6
2	B	19	LYS	2.5
1	A	272	LEU	2.5
1	A	222	GLU	2.5
1	A	260	HIS	2.4
1	A	218	GLN	2.4
2	B	76	ASP	2.4
4	D	200	ILE	2.4
4	D	169	ALA	2.4
4	D	35	GLU	2.3
4	D	50	HIS	2.3
1	A	257	TYR	2.3
4	D	5	HIS	2.3
4	D	9	SER	2.3
1	A	17	ARG	2.3
4	D	147	GLU	2.3
4	D	13	HIS	2.2
1	A	258	THR	2.2
4	D	122	GLU	2.2
1	A	226	GLN	2.1
4	D	83	VAL	2.1
1	A	228	THR	2.1
2	B	73	THR	2.1

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Mol	Chain	Res	Type	RSRZ
4	D	28	CYS	2.1
1	A	256	ARG	2.1
4	D	159	THR	2.0
4	D	199	VAL	2.0
2	B	20	SER	2.0
2	B	42	ASN	2.0

6.2 Non-standard residues in protein, DNA, RNA chains ⓘ

There are no non-standard protein/DNA/RNA residues in this entry.

6.3 Carbohydrates ⓘ

There are no oligosaccharides in this entry.

6.4 Ligands ⓘ

There are no ligands in this entry.

6.5 Other polymers ⓘ

There are no such residues in this entry.