Full wwPDB X-ray Structure Validation Report (i)

Feb 23, 2026 – 10:09 AM EST

PDB ID	:	9NKH / pdb_00009nkh
Title	:	Conformational flexibility in HLA-B8: peptide tuning structural and dynamical changes
Authors	:	Li, L.; Bouvier, M.
Deposited on	:	2025-02-28
Resolution	:	1.94 Å(reported)

The following versions of software and data (see references (i)) were used in the production of this report:

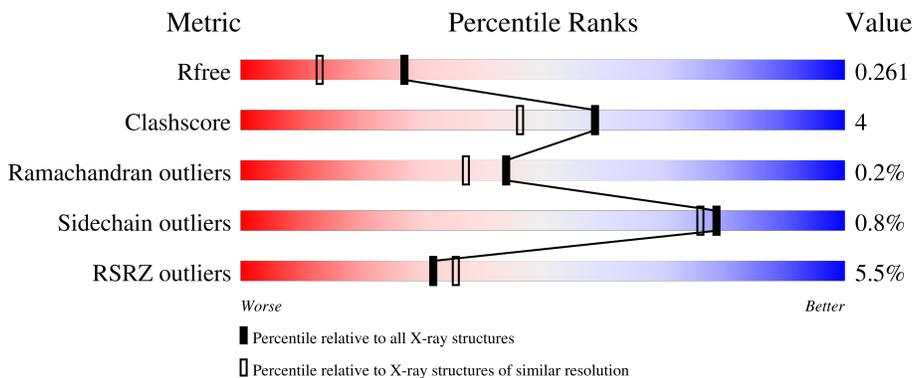|		
MolProbity	:	4-5-2 with Phenix2.0
Xtriage (Phenix)	:	2.0
EDS	:	3.0
Percentile statistics	:	20231227.v01 (using entries in the PDB archive December 27th 2023)
CCP4	:	9.0.010 (Gargrove)
Density-Fitness	:	1.0.12
Ideal geometry (proteins)	:	Engh & Huber (2001)
Ideal geometry (DNA, RNA)	:	Parkinson et al. (1996)
Validation Pipeline (wwPDB-VP)	:	2.48.1

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 1.94 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	Percentile Ranks	Value
Rfree		0.261
Clashscore		4
Ramachandran outliers		0.2%
Sidechain outliers		0.8%
RSRZ outliers		5.5%

Worse   *Better*

▮ Percentile relative to all X-ray structures

◻ Percentile relative to X-ray structures of similar resolution

Metric	Whole archive (#Entries)	Similar resolution (#Entries, resolution range(Å))
R_{free}	164625	1306 (1.94-1.94)
Clashscore	180529	1400 (1.94-1.94)
Ramachandran outliers	177936	1387 (1.94-1.94)
Sidechain outliers	177891	1387 (1.94-1.94)
RSRZ outliers	164620	1306 (1.94-1.94)

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	275	4% / 76% / 8% / 16%
1	D	275	5% / 71% / 12% / 17%
2	B	100	2% / 92% / 8%
2	E	100	6% / 84% / 16%
3	C	20	45% / 55%

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Mol	Chain	Length	Quality of chain
3	F	20	15% 45% 55%

2 Entry composition ⓘ

There are 4 unique types of molecules in this entry. The entry contains 5665 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 protein.

Mol	Chain	Residues	Atoms					ZeroOcc	AltConf	Trace
1	A	232	Total 1906	C 1183	N 350	O 365	S 8	0	0	0
1	D	228	Total 1872	C 1162	N 341	O 361	S 8	0	0	0

There are 2 discrepancies between the modelled and reference sequences:

Chain	Residue	Modelled	Actual	Comment	Reference
A	76	CYS	GLU	engineered mutation	UNP A0A3G6II09
D	76	CYS	GLU	engineered mutation	UNP A0A3G6II09

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

Mol	Chain	Residues	Atoms					ZeroOcc	AltConf	Trace
2	B	100	Total 836	C 533	N 141	O 158	S 4	0	0	0
2	E	100	Total 836	C 533	N 141	O 158	S 4	0	0	0

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 ARG-ALA-ARG-ALA-ARG-ALA-ARG-ALA-ARG-ALA-ARG-ALA-PHE-LEU-LYS-LYS-LYS-TYR-CYS-LEU.

Mol	Chain	Residues	Atoms					ZeroOcc	AltConf	Trace
3	C	9	Total 73	C 51	N 11	O 10	S 1	0	0	0

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W O R L D W I D E
wwPDB
PROTEIN DATA BANK

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Mol	Chain	Residues	Atoms					ZeroOcc	AltConf	Trace
3	F	9	Total 73	C 51	N 11	O 10	S 1	0	0	0

- Molecule 4 is water.

Mol	Chain	Residues	Atoms		ZeroOcc	AltConf
4	A	32	Total 32	O 32	0	0
4	B	23	Total 23	O 23	0	0
4	D	8	Total 8	O 8	0	0
4	E	6	Total 6	O 6	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 protein

Chain A:

• Molecule 1: MHC class I protein

Chain D:

• Molecule 2: Beta-2-microglobulin

Chain B:

• Molecule 2: Beta-2-microglobulin

Chain E:

• Molecule 3: ARG-ALA-ARG-ALA-ARG-ALA-ARG-ALA-ARG-ALA-ARG-ALA-PHE-LEU-L YS-LYS-LYS-TYR-CYS-LEU

Chain C:

• Molecule 3: ARG-ALA-ARG-ALA-ARG-ALA-ARG-ALA-ARG-ALA-ARG-ALA-PHE-LEU-L YS-LYS-LYS-TYR-CYS-LEU

Chain F:

4 Data and refinement statistics ⓘ

Property	Value	Source
Space group	P 1 21 1	Depositor
Cell constants a, b, c, α, β, γ	68.68Å 86.01Å 70.43Å 90.00° 99.59° 90.00°	Depositor
Resolution (Å)	27.02 – 1.94 27.02 – 1.94	Depositor EDS
% Data completeness (in resolution range)	93.8 (27.02-1.94) 93.8 (27.02-1.94)	Depositor EDS
R_{merge}	0.12	Depositor
R_{sym}	(Not available)	Depositor
$< I/\sigma(I) >$ [1]	1.64 (at 1.93Å)	Xtriage
Refinement program	PHENIX (1.21.1_5286)	Depositor
R, R_{free}	0.238 , 0.259 0.238 , 0.261	Depositor DCC
R_{free} test set	2760 reflections (4.58%)	wwPDB-VP
Wilson B-factor (Å^2)	40.8	Xtriage
Anisotropy	0.350	Xtriage
Bulk solvent k_{sol}(e/Å^3), B_{sol}(Å^2)	0.31 , 35.8	EDS
L-test for twinning [2]	$< |L| > = 0.48, < L^2 > = 0.31$	Xtriage
Estimated twinning fraction	0.024 for l,-k,h	Xtriage
F_o,F_c correlation	0.95	EDS
Total number of atoms	5665	wwPDB-VP
Average B, all atoms (Å^2)	61.0	wwPDB-VP

Xtriage's analysis on translational NCS is as follows: *The largest off-origin peak in the Patterson function is 5.28% 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 ⓘ

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	0.26	0/1952	0.47	0/2645
1	D	0.27	0/1919	0.45	0/2603
2	B	0.26	0/859	0.49	0/1162
2	E	0.21	0/859	0.46	0/1162
3	C	0.35	0/74	0.41	0/97
3	F	0.21	0/74	0.38	0/97
All	All	0.26	0/5737	0.46	0/7766

There are no bond length outliers.

There are no bond angle outliers.

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	1906	0	1778	15	0
1	D	1872	0	1730	19	0
2	B	836	0	803	5	0
2	E	836	0	803	13	0
3	C	73	0	79	0	0
3	F	73	0	79	0	0
4	A	32	0	0	0	0
4	B	23	0	0	0	0
4	D	8	0	0	0	0
4	E	6	0	0	0	0

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Mol	Chain	Non-H	H(model)	H(added)	Clashes	Symm-Clashes
All	All	5665	0	5272	47	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 4.

All (47) 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:E:17:ASN:HD21	2:E:97:ARG:HH12	1.38	0.69
2:E:73:THR:O	2:E:75:LYS:N	2.25	0.69
1:D:82:ARG:NH2	1:D:89:GLU:OE2	2.26	0.68
1:D:126:LEU:HD11	1:D:130:LEU:HA	1.78	0.66
1:A:119:ASP:HB3	2:B:0:MET:HB2	1.83	0.59
1:D:119:ASP:HB3	2:E:0:MET:HG3	1.86	0.58
1:D:5:MET:HB2	1:D:168:LEU:HD13	1.87	0.57
2:E:73:THR:C	2:E:75:LYS:H	2.13	0.56
2:E:17:ASN:ND2	2:E:97:ARG:HH22	2.04	0.55
1:A:33:PHE:CD2	1:A:34:VAL:HG23	2.42	0.54
1:D:239:ARG:N	1:D:239:ARG:HE	2.06	0.54
1:A:5:MET:HB2	1:A:168:LEU:HD13	1.89	0.54
1:D:214:THR:HG23	1:D:262:GLN:HB3	1.91	0.53
2:B:4:THR:HG22	2:B:86:THR:HB	1.90	0.53
1:D:260:HIS:HA	1:D:270:LEU:O	2.09	0.52
2:E:4:THR:HG22	2:E:86:THR:HB	1.92	0.51
2:E:58:LYS:HD3	2:E:58:LYS:H	1.74	0.51
1:A:111:ARG:HG3	1:A:128:GLU:HG2	1.94	0.49
1:D:71:THR:O	1:D:75:ARG:HG3	2.12	0.49
1:A:28:VAL:HG23	1:A:33:PHE:CD1	2.48	0.48
1:D:67:PHE:O	1:D:71:THR:HG23	2.13	0.48
1:D:215:LEU:HD22	1:D:261:VAL:HG22	1.96	0.47
1:A:5:MET:HE3	1:A:33:PHE:CZ	2.50	0.47
1:A:67:PHE:O	1:A:71:THR:HG23	2.15	0.47
1:A:86:ASN:N	1:A:86:ASN:HD22	2.12	0.47
2:E:37:VAL:HG12	2:E:82:VAL:HG13	1.96	0.47
1:D:126:LEU:CD1	1:D:130:LEU:HA	2.44	0.45
1:D:35:ARG:CZ	2:E:53:ASP:HB3	2.46	0.45
2:B:17:ASN:HD21	2:B:74:GLU:HB2	1.82	0.44
1:D:60:TRP:CG	1:D:61:ASP:H	2.36	0.44
2:E:51:HIS:HB3	2:E:66:TYR:CD2	2.54	0.43
1:A:21:ARG:CZ	1:A:23:ILE:HD11	2.48	0.43
1:A:81:LEU:HD13	1:A:118:TYR:CD1	2.53	0.43

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Atom-1	Atom-2	Interatomic distance (Å)	Clash overlap (Å)
1:A:194:ILE:HD11	1:A:200:THR:HG22	2.00	0.43
2:B:22:PHE:CE1	2:B:69:GLU:HG3	2.54	0.43
1:D:9:ASP:O	1:D:96:GLN:HA	2.18	0.43
1:A:117:ALA:HB2	2:B:60:TRP:CE2	2.54	0.42
1:A:274:TRP:CE2	1:A:275:GLU:HG2	2.55	0.42
1:D:200:THR:HG22	1:D:248:VAL:HG22	2.02	0.42
1:D:219:ARG:HB2	1:D:257:TYR:CE2	2.55	0.41
1:D:220:ASP:OD1	1:D:256:ARG:HD2	2.21	0.41
1:A:230:LEU:HD12	1:D:138:THR:HG21	2.02	0.41
2:E:50:GLU:HB2	2:E:67:TYR:CE1	2.56	0.41
2:E:58:LYS:HB2	2:E:58:LYS:HE2	1.90	0.41
2:E:97:ARG:H	2:E:97:ARG:HG2	1.39	0.41
1:A:183:ASP:N	1:A:183:ASP:OD1	2.54	0.40
1:D:266:LEU:CD2	1:D:270:LEU:HD23	2.51	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	222/275 (81%)	215 (97%)	7 (3%)	0	100	100
1	D	218/275 (79%)	211 (97%)	7 (3%)	0	100	100
2	B	98/100 (98%)	95 (97%)	3 (3%)	0	100	100
2	E	98/100 (98%)	95 (97%)	2 (2%)	1 (1%)	13	5
3	C	7/20 (35%)	7 (100%)	0	0	100	100
3	F	7/20 (35%)	7 (100%)	0	0	100	100
All	All	650/790 (82%)	630 (97%)	19 (3%)	1 (0%)	44	37

All (1) Ramachandran outliers are listed below:

Mol	Chain	Res	Type
2	E	74	GLU

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	201/234 (86%)	199 (99%)	2 (1%)	73	68
1	D	197/234 (84%)	194 (98%)	3 (2%)	60	52
2	B	95/95 (100%)	95 (100%)	0	100	100
2	E	95/95 (100%)	95 (100%)	0	100	100
3	C	7/14 (50%)	7 (100%)	0	100	100
3	F	7/14 (50%)	7 (100%)	0	100	100
All	All	602/686 (88%)	597 (99%)	5 (1%)	79	76

All (5) residues with a non-rotameric sidechain are listed below:

Mol	Chain	Res	Type
1	A	31	THR
1	A	200	THR
1	D	88	SER
1	D	197	HIS
1	D	223	ASP

Sometimes sidechains can be flipped to improve hydrogen bonding and reduce clashes. All (6) such sidechains are listed below:

Mol	Chain	Res	Type
1	A	86	ASN
2	B	2	GLN
2	B	13	HIS
2	B	17	ASN
2	E	13	HIS
2	E	17	ASN

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(Å^2)	Q<0.9
1	A	232/275 (84%)	0.51	11 (4%)	37	41	33, 52, 87, 109	0
1	D	228/275 (82%)	0.79	15 (6%)	26	28	42, 65, 98, 123	0
2	B	100/100 (100%)	0.33	2 (2%)	64	70	31, 51, 82, 121	0
2	E	100/100 (100%)	0.68	6 (6%)	29	31	40, 67, 108, 118	0
3	C	9/20 (45%)	0.84	0	100	100	40, 46, 71, 73	0
3	F	9/20 (45%)	1.69	3 (33%)	1	1	53, 64, 73, 82	0
All	All	678/790 (85%)	0.62	37 (5%)	32	35	31, 59, 96, 123	0

All (37) RSRZ outliers are listed below:

Mol	Chain	Res	Type	RSRZ
3	F	0	ALA	5.1
1	D	60	TRP	4.9
1	A	167	TRP	4.7
1	A	168	LEU	4.6
1	D	36	PHE	4.4
2	E	40	LEU	3.8
1	A	171	TYR	3.5
1	A	109	LEU	2.9
1	A	110	LEU	2.9
3	F	8	LEU	2.7
1	A	225	THR	2.7
1	A	160	LEU	2.7
1	D	168	LEU	2.6
1	D	69	THR	2.6
1	D	165	VAL	2.5
1	D	247	VAL	2.5
2	E	22	PHE	2.5
1	D	182	ALA	2.5
2	E	70	PHE	2.5

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Mol	Chain	Res	Type	RSRZ
1	D	167	TRP	2.4
1	A	33	PHE	2.4
1	D	197	HIS	2.3
1	D	20	PRO	2.3
2	E	37	VAL	2.3
1	A	20	PRO	2.3
1	D	228	THR	2.3
2	E	66	TYR	2.3
1	D	142	ILE	2.2
2	B	0	MET	2.1
1	D	201	LEU	2.1
1	A	36	PHE	2.1
1	D	91	GLY	2.1
2	B	47	GLU	2.1
2	E	78	TYR	2.1
3	F	6	TYR	2.0
1	D	274	TRP	2.0
1	A	182	ALA	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.