



Full wwPDB X-ray Structure Validation Report ⓘ

May 29, 2024 – 04:43 PM EDT

PDB ID : 1HHK
Title : THE ANTIGENIC IDENTITY OF PEPTIDE(SLASH)MHC COMPLEXES:
A COMPARISON OF THE CONFORMATION OF FIVE PEPTIDES PRE-
SENTED BY HLA-A2
Authors : Madden, D.R.; Garboczi, D.N.; Wiley, D.C.
Deposited on : 1993-06-30
Resolution : 2.50 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 : 4.02b-467
Xtrriage (Phenix) : **NOT EXECUTED**
EDS : **NOT EXECUTED**
Percentile statistics : 20191225.v01 (using entries in the PDB archive December 25th 2019)
Ideal geometry (proteins) : Engh & Huber (2001)
Ideal geometry (DNA, RNA) : Parkinson et al. (1996)
Validation Pipeline (wwPDB-VP) : 2.36.2

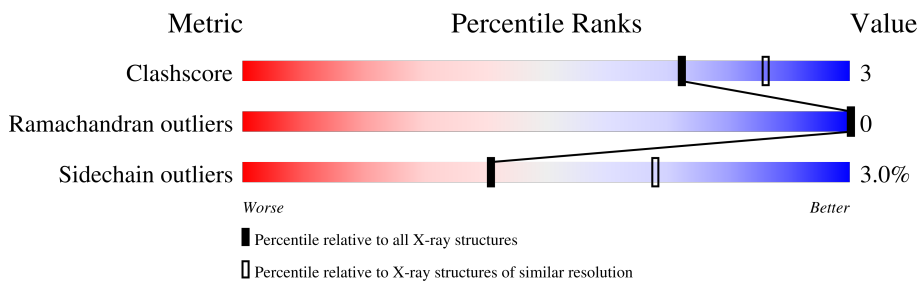
1 Overall quality at a glance

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))
Clashscore	141614	5346 (2.50-2.50)
Ramachandran outliers	138981	5231 (2.50-2.50)
Sidechain outliers	138945	5233 (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 $\leq 5\%$.

Note EDS was not executed.

Mol	Chain	Length	Quality of chain
1	A	275	
1	D	275	
2	B	100	
2	E	100	
3	C	9	
3	F	9	

2 Entry composition [i](#)

There are 3 unique types of molecules in this entry. The entry contains 6322 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 CLASS I HISTOCOMPATIBILITY ANTIGEN (HLA-A*0201) (ALPHA CHAIN).

Mol	Chain	Residues	Atoms					ZeroOcc	AltConf	Trace
1	A	275	Total	C	N	O	S	14	0	0
			2247	1403	409	426	9			
1	D	275	Total	C	N	O	S	14	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	10	0	0
			837	533	141	159	4			
2	E	100	Total	C	N	O	S	10	0	0
			837	533	141	159	4			

- Molecule 3 is a protein called NONAMERIC PEPTIDE FROM HTLV-1 TAX PROTEIN (RESIDUES 11-19).

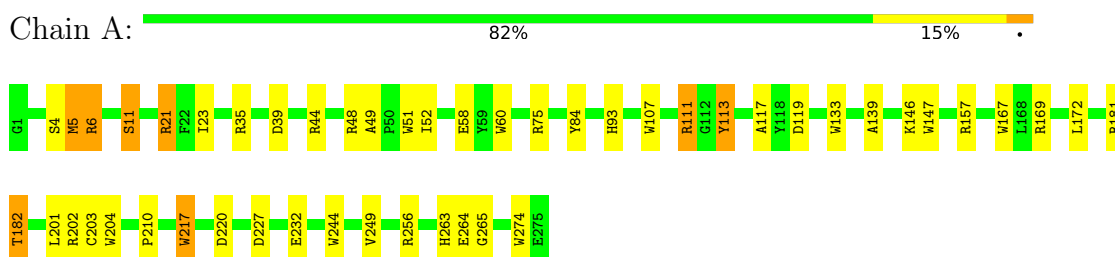
Mol	Chain	Residues	Atoms				ZeroOcc	AltConf	Trace
3	C	9	Total	C	N	O	0	0	0
			77	56	9	12			
3	F	9	Total	C	N	O	0	0	0
			77	56	9	12			

3 Residue-property plots [i](#)

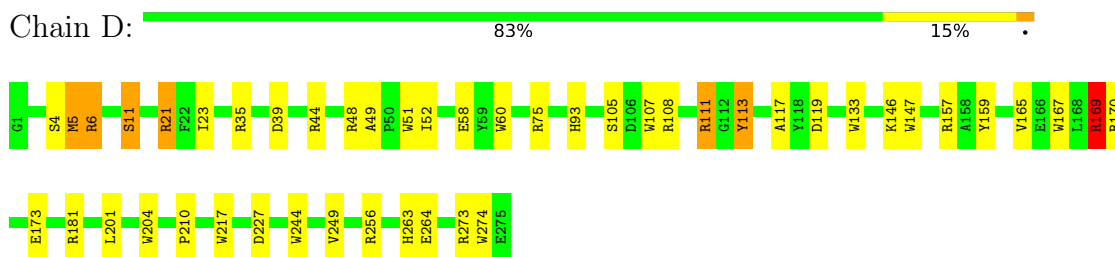
These plots are drawn for all protein, RNA, DNA and oligosaccharide chains in the entry. The first graphic for a chain summarises the proportions of the various outlier classes displayed in the second graphic. The second graphic shows the sequence view annotated by issues in geometry. Residues are color-coded 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. 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.

Note EDS was not executed.

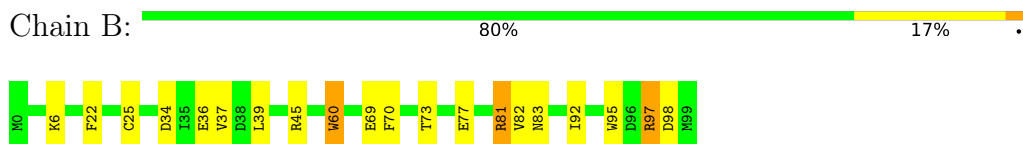
- Molecule 1: CLASS I HISTOCOMPATIBILITY ANTIGEN (HLA-A*0201) (ALPHA CHAIN)



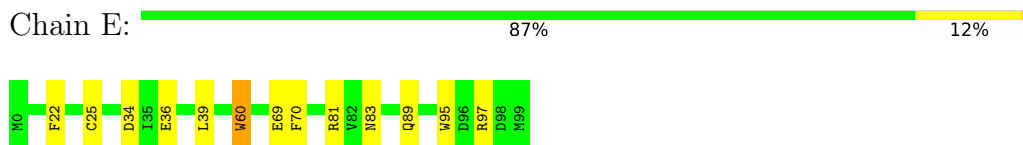
- Molecule 1: CLASS I HISTOCOMPATIBILITY ANTIGEN (HLA-A*0201) (ALPHA CHAIN)



- Molecule 2: BETA 2-MICROGLOBULIN



- Molecule 2: BETA 2-MICROGLOBULIN

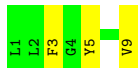


- Molecule 3: NONAMERIC PEPTIDE FROM HTLV-1 TAX PROTEIN (RESIDUES 11-19)





- Molecule 3: NONAMERIC PEPTIDE FROM HTLV-1 TAX PROTEIN (RESIDUES 11-19)



4 Data and refinement statistics

Xtrriage (Phenix) and EDS were not executed - this section is therefore incomplete.

Property	Value	Source
Space group	P 1	Depositor
Cell constants a, b, c, α , β , γ	50.56Å 63.79Å 75.08Å 81.58° 75.66° 77.38°	Depositor
Resolution (Å)	(Not available) – 2.50	Depositor
% Data completeness (in resolution range)	(Not available) ((Not available)-2.50)	Depositor
R_{merge}	(Not available)	Depositor
R_{sym}	(Not available)	Depositor
Refinement program	X-PLOR	Depositor
R, R_{free}	0.262 , (Not available)	Depositor
Estimated twinning fraction	No twinning to report.	Xtrriage
Total number of atoms	6322	wwPDB-VP
Average B, all atoms (Å ²)	21.0	wwPDB-VP

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	0.87	0/2312	1.56	41/3137 (1.3%)
1	D	0.86	0/2312	1.55	46/3137 (1.5%)
2	B	0.84	0/860	1.45	16/1162 (1.4%)
2	E	0.85	0/860	1.38	11/1162 (0.9%)
3	C	0.68	0/80	1.36	0/108
3	F	0.71	0/80	1.37	0/108
All	All	0.86	0/6504	1.52	114/8814 (1.3%)

There are no bond length outliers.

All (114) bond angle outliers are listed below:

Mol	Chain	Res	Type	Atoms	Z	Observed(°)	Ideal(°)
1	A	5	MET	CG-SD-CE	-15.47	75.44	100.20
1	D	5	MET	CG-SD-CE	-14.15	77.57	100.20
2	B	97	ARG	NE-CZ-NH2	-10.21	115.20	120.30
2	B	95	TRP	CD1-CG-CD2	9.23	113.68	106.30
1	A	133	TRP	CD1-CG-CD2	9.15	113.62	106.30
1	A	204	TRP	CD1-CG-CD2	9.09	113.58	106.30
1	D	204	TRP	CD1-CG-CD2	9.07	113.56	106.30
1	D	133	TRP	CD1-CG-CD2	8.72	113.28	106.30
1	D	157	ARG	NE-CZ-NH2	-8.59	116.00	120.30
1	A	51	TRP	CD1-CG-CD2	8.56	113.15	106.30
2	B	60	TRP	CD1-CG-CD2	8.53	113.12	106.30
1	A	217	TRP	CD1-CG-CD2	8.51	113.11	106.30
1	D	217	TRP	CD1-CG-CD2	8.48	113.09	106.30
1	A	181	ARG	NE-CZ-NH2	-8.44	116.08	120.30
2	B	97	ARG	NE-CZ-NH1	8.33	124.47	120.30
2	E	95	TRP	CD1-CG-CD2	8.30	112.94	106.30
1	D	274	TRP	CD1-CG-CD2	8.29	112.93	106.30
1	D	51	TRP	CD1-CG-CD2	8.26	112.91	106.30
2	E	60	TRP	CD1-CG-CD2	8.11	112.79	106.30
1	A	274	TRP	CD1-CG-CD2	8.11	112.78	106.30
1	A	111	ARG	NE-CZ-NH2	-7.99	116.31	120.30

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Mol	Chain	Res	Type	Atoms	Z	Observed(°)	Ideal(°)
1	A	167	TRP	CD1-CG-CD2	7.94	112.65	106.30
1	D	244	TRP	CD1-CG-CD2	7.93	112.65	106.30
1	D	244	TRP	CE2-CD2-CG	-7.93	100.96	107.30
1	A	244	TRP	CD1-CG-CD2	7.84	112.57	106.30
1	A	244	TRP	CE2-CD2-CG	-7.82	101.05	107.30
2	B	95	TRP	CE2-CD2-CG	-7.80	101.06	107.30
1	D	274	TRP	CE2-CD2-CG	-7.73	101.11	107.30
1	A	51	TRP	CE2-CD2-CG	-7.71	101.13	107.30
1	D	60	TRP	CD1-CG-CD2	7.69	112.45	106.30
1	D	51	TRP	CE2-CD2-CG	-7.66	101.17	107.30
2	E	95	TRP	CE2-CD2-CG	-7.66	101.17	107.30
1	A	204	TRP	CE2-CD2-CG	-7.58	101.24	107.30
1	A	274	TRP	CE2-CD2-CG	-7.57	101.24	107.30
1	A	60	TRP	CD1-CG-CD2	7.56	112.35	106.30
1	D	6	ARG	NE-CZ-NH1	7.47	124.04	120.30
1	D	60	TRP	CE2-CD2-CG	-7.46	101.33	107.30
1	D	204	TRP	CE2-CD2-CG	-7.44	101.35	107.30
1	A	133	TRP	CE2-CD2-CG	-7.34	101.43	107.30
1	D	167	TRP	CD1-CG-CD2	7.32	112.16	106.30
1	D	111	ARG	NE-CZ-NH2	-7.32	116.64	120.30
1	A	60	TRP	CE2-CD2-CG	-7.32	101.45	107.30
1	A	157	ARG	NE-CZ-NH2	-7.24	116.68	120.30
1	D	217	TRP	CE2-CD2-CG	-7.21	101.53	107.30
2	B	60	TRP	CE2-CD2-CG	-7.17	101.56	107.30
2	E	89	GLN	CA-CB-CG	-7.16	97.66	113.40
1	A	21	ARG	NE-CZ-NH1	7.15	123.88	120.30
2	E	60	TRP	CE2-CD2-CG	-7.12	101.60	107.30
1	A	167	TRP	CE2-CD2-CG	-7.11	101.61	107.30
1	A	217	TRP	CE2-CD2-CG	-7.04	101.67	107.30
1	D	133	TRP	CE2-CD2-CG	-7.00	101.70	107.30
1	A	48	ARG	NE-CZ-NH2	-7.00	116.80	120.30
1	A	107	TRP	CD1-CG-CD2	7.00	111.90	106.30
1	D	107	TRP	CD1-CG-CD2	6.95	111.86	106.30
1	D	167	TRP	CE2-CD2-CG	-6.92	101.76	107.30
2	B	45	ARG	NE-CZ-NH2	-6.91	116.84	120.30
1	D	107	TRP	CE2-CD2-CG	-6.68	101.96	107.30
1	D	44	ARG	NE-CZ-NH1	6.67	123.64	120.30
1	D	159	TYR	CB-CG-CD2	-6.67	117.00	121.00
1	D	169	ARG	CA-CB-CG	6.66	128.06	113.40
1	D	147	TRP	CD1-CG-CD2	6.61	111.59	106.30
1	D	113	TYR	CB-CG-CD2	-6.45	117.13	121.00
1	D	170	ARG	NE-CZ-NH2	-6.38	117.11	120.30

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Mol	Chain	Res	Type	Atoms	Z	Observed(°)	Ideal(°)
1	D	157	ARG	CG-CD-NE	-6.37	98.42	111.80
1	D	147	TRP	CE2-CD2-CG	-6.32	102.24	107.30
1	A	220	ASP	CB-CG-OD1	6.26	123.93	118.30
1	A	147	TRP	CE2-CD2-CG	-6.24	102.31	107.30
1	A	113	TYR	CB-CG-CD2	-6.22	117.27	121.00
1	D	256	ARG	NE-CZ-NH2	-6.17	117.22	120.30
1	A	107	TRP	CE2-CD2-CG	-6.16	102.37	107.30
1	A	147	TRP	CD1-CG-CD2	6.14	111.21	106.30
1	D	181	ARG	NE-CZ-NH2	-6.14	117.23	120.30
2	B	77	GLU	CA-CB-CG	6.12	126.86	113.40
1	A	6	ARG	NE-CZ-NH1	6.06	123.33	120.30
1	D	21	ARG	NE-CZ-NH1	5.97	123.28	120.30
2	B	95	TRP	CG-CD2-CE3	5.96	139.27	133.90
1	D	273	ARG	NE-CZ-NH1	5.95	123.27	120.30
2	B	77	GLU	OE1-CD-OE2	-5.82	116.31	123.30
1	A	157	ARG	CG-CD-NE	-5.80	99.61	111.80
2	E	97	ARG	CA-CB-CG	5.74	126.02	113.40
2	E	81	ARG	NE-CZ-NH1	5.73	123.16	120.30
1	A	44	ARG	NE-CZ-NH1	5.68	123.14	120.30
1	A	256	ARG	NE-CZ-NH2	-5.65	117.47	120.30
1	A	217	TRP	CG-CD1-NE1	-5.64	104.46	110.10
1	D	133	TRP	CG-CD1-NE1	-5.63	104.47	110.10
1	A	21	ARG	NE-CZ-NH2	-5.62	117.49	120.30
2	E	95	TRP	CG-CD2-CE3	5.60	138.94	133.90
1	D	39	ASP	CB-CG-OD1	5.59	123.33	118.30
1	A	264	GLU	CA-CB-CG	5.57	125.65	113.40
1	A	133	TRP	CG-CD1-NE1	-5.56	104.54	110.10
1	A	5	MET	CA-CB-CG	-5.55	103.86	113.30
1	D	274	TRP	CG-CD2-CE3	5.50	138.85	133.90
1	A	39	ASP	CB-CG-OD1	5.48	123.23	118.30
1	D	108	ARG	NE-CZ-NH2	-5.47	117.56	120.30
2	E	60	TRP	CG-CD1-NE1	-5.47	104.63	110.10
1	D	204	TRP	CG-CD1-NE1	-5.46	104.64	110.10
2	B	81	ARG	NE-CZ-NH2	-5.42	117.59	120.30
1	D	264	GLU	CA-CB-CG	5.42	125.32	113.40
1	A	274	TRP	CG-CD2-CE3	5.38	138.75	133.90
1	D	217	TRP	CG-CD1-NE1	-5.38	104.72	110.10
1	D	21	ARG	NE-CZ-NH2	-5.38	117.61	120.30
2	B	95	TRP	CG-CD1-NE1	-5.34	104.76	110.10
1	D	48	ARG	NE-CZ-NH2	-5.34	117.63	120.30
2	B	60	TRP	CB-CG-CD1	-5.32	120.08	127.00
2	E	60	TRP	CB-CG-CD1	-5.32	120.09	127.00

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Mol	Chain	Res	Type	Atoms	Z	Observed(°)	Ideal(°)
2	B	60	TRP	CG-CD1-NE1	-5.31	104.79	110.10
1	A	202	ARG	NE-CZ-NH2	-5.29	117.66	120.30
1	A	244	TRP	CG-CD2-CE3	5.27	138.64	133.90
2	B	60	TRP	CG-CD2-CE3	5.26	138.63	133.90
1	D	274	TRP	CB-CG-CD1	-5.26	120.17	127.00
1	D	244	TRP	CG-CD2-CE3	5.25	138.63	133.90
1	D	173	GLU	OE1-CD-OE2	-5.22	117.04	123.30
2	B	95	TRP	CB-CG-CD1	-5.16	120.29	127.00
2	E	60	TRP	CG-CD2-CE3	5.02	138.42	133.90

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	0
1	D	2247	0	2096	13	0
2	B	837	0	803	8	0
2	E	837	0	803	4	0
3	C	77	0	79	2	0
3	F	77	0	79	2	0
All	All	6322	0	5956	41	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 (41) 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:36:GLU:HB3	2:E:83:ASN:HB2	1.79	0.65
2:B:36:GLU:HB3	2:B:83:ASN:HB2	1.79	0.64
1:A:4:SER:HB2	1:A:6:ARG:HH12	1.68	0.58
1:D:4:SER:HB2	1:D:6:ARG:HH12	1.69	0.58
2:E:22:PHE:CE2	2:E:69:GLU:HG2	2.38	0.57

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Atom-1	Atom-2	Interatomic distance (Å)	Clash overlap (Å)
2:B:22:PHE:CE2	2:B:69:GLU:HG2	2.40	0.57
1:A:201:LEU:HD12	1:A:249:VAL:HG21	1.87	0.56
1:A:93:HIS:HD2	1:A:119:ASP:OD2	1.89	0.56
1:D:201:LEU:HD12	1:D:249:VAL:HG21	1.86	0.56
1:D:93:HIS:HD2	1:D:119:ASP:OD2	1.89	0.55
1:A:4:SER:HB2	1:A:6:ARG:NH1	2.25	0.52
1:D:210:PRO:O	1:D:263:HIS:HE1	1.91	0.52
2:E:25:CYS:HB2	2:E:39:LEU:HD21	1.92	0.52
1:A:210:PRO:O	1:A:263:HIS:HE1	1.93	0.52
2:B:25:CYS:HB2	2:B:39:LEU:HD21	1.93	0.51
1:D:4:SER:HB2	1:D:6:ARG:NH1	2.24	0.51
1:D:117:ALA:HB2	2:E:60:TRP:CE2	2.46	0.50
1:A:111:ARG:HD2	1:A:113:TYR:OH	2.10	0.49
1:D:111:ARG:HD2	1:D:113:TYR:OH	2.12	0.49
1:A:232:GLU:OE2	2:B:6:LYS:NZ	2.42	0.49
1:D:165:VAL:O	1:D:169:ARG:HG2	2.12	0.48
1:A:49:ALA:O	1:A:52:ILE:HG22	2.14	0.48
1:A:182:THR:HG23	1:A:265:GLY:HA2	1.97	0.47
1:A:169:ARG:HA	1:A:172:LEU:HD12	1.96	0.47
1:D:49:ALA:O	1:D:52:ILE:HG22	2.14	0.47
1:D:21:ARG:HH21	1:D:23:ILE:HD11	1.80	0.46
1:D:146:LYS:NZ	3:F:9:VAL:O	2.49	0.46
1:A:6:ARG:NH2	1:A:113:TYR:CE1	2.83	0.46
1:D:6:ARG:NH2	1:D:113:TYR:CE1	2.84	0.46
2:B:73:THR:O	2:B:97:ARG:NH2	2.49	0.46
1:D:11:SER:HA	1:D:21:ARG:O	2.15	0.46
1:A:11:SER:HA	1:A:21:ARG:O	2.16	0.45
3:F:3:PHE:CZ	3:F:5:TYR:HB2	2.53	0.44
1:A:21:ARG:HH21	1:A:23:ILE:HD11	1.82	0.44
3:C:3:PHE:CZ	3:C:5:TYR:HB2	2.53	0.43
2:B:81:ARG:HG3	2:B:92:ILE:HG12	2.00	0.42
1:A:84:TYR:HB3	1:A:139:ALA:HB1	2.02	0.42
1:A:117:ALA:HB2	2:B:60:TRP:CE2	2.56	0.41
1:A:146:LYS:NZ	3:C:9:VAL:O	2.53	0.41
1:A:203:CYS:HB2	1:A:217:TRP:CZ2	2.56	0.40
2:B:37:VAL:HG22	2:B:82:VAL:HG22	2.03	0.40

There are no symmetry-related clashes.

5.3 Torsion angles [i](#)

5.3.1 Protein backbone [i](#)

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%)	267 (98%)	6 (2%)	0	100	100
1	D	273/275 (99%)	269 (98%)	4 (2%)	0	100	100
2	B	98/100 (98%)	97 (99%)	1 (1%)	0	100	100
2	E	98/100 (98%)	97 (99%)	1 (1%)	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%)	744 (98%)	12 (2%)	0	100	100

There are no Ramachandran outliers to report.

5.3.2 Protein sidechains [i](#)

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%)	224 (97%)	7 (3%)	41	68
1	D	231/231 (100%)	223 (96%)	8 (4%)	36	62
2	B	95/95 (100%)	92 (97%)	3 (3%)	39	65
2	E	95/95 (100%)	93 (98%)	2 (2%)	53	78
3	C	8/8 (100%)	8 (100%)	0	100	100
3	F	8/8 (100%)	8 (100%)	0	100	100
All	All	668/668 (100%)	648 (97%)	20 (3%)	41	68

All (20) residues with a non-rotameric sidechain are listed below:

Mol	Chain	Res	Type
1	A	5	MET
1	A	11	SER
1	A	35	ARG
1	A	58	GLU
1	A	75	ARG
1	A	182	THR
1	A	227	ASP
2	B	34	ASP
2	B	70	PHE
2	B	98	ASP
1	D	5	MET
1	D	11	SER
1	D	35	ARG
1	D	58	GLU
1	D	75	ARG
1	D	105	SER
1	D	169	ARG
1	D	227	ASP
2	E	34	ASP
2	E	70	PHE

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	93	HIS
1	A	114	HIS
1	A	263	HIS
1	D	93	HIS
1	D	114	HIS
1	D	263	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 monosaccharides 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 [i](#)

6.1 Protein, DNA and RNA chains [i](#)

EDS was not executed - this section is therefore empty.

6.2 Non-standard residues in protein, DNA, RNA chains [i](#)

EDS was not executed - this section is therefore empty.

6.3 Carbohydrates [i](#)

EDS was not executed - this section is therefore empty.

6.4 Ligands [i](#)

EDS was not executed - this section is therefore empty.

6.5 Other polymers [i](#)

EDS was not executed - this section is therefore empty.