



# wwPDB X-ray Structure Validation Summary Report ⓘ

Mar 8, 2026 – 07:34 AM UTC

PDB ID : 4YM5 / pdb\_00004ym5  
Title : Crystal structure of the human nucleosome containing 6-4PP (inside)  
Authors : Osakabe, A.; Tachiwana, H.; Kagawa, W.; Horikoshi, N.; Matsumoto, S.; Hasegawa, M.; Matsumoto, N.; Toga, T.; Yamamoto, J.; Hanaoka, F.; Thoma, N.H.; Sugasawa, K.; Iwai, S.; Kurumizaka, H.  
Deposited on : 2015-03-06  
Resolution : 4.00 Å(reported)

This is a wwPDB X-ray Structure Validation Summary Report for a publicly released PDB entry.

We welcome your comments at [validation@mail.wwpdb.org](mailto: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>.

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

MolProbity : 4-5-2 with Phenix2.0  
Mogul : 2022.3.0, CSD as543be (2022)  
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

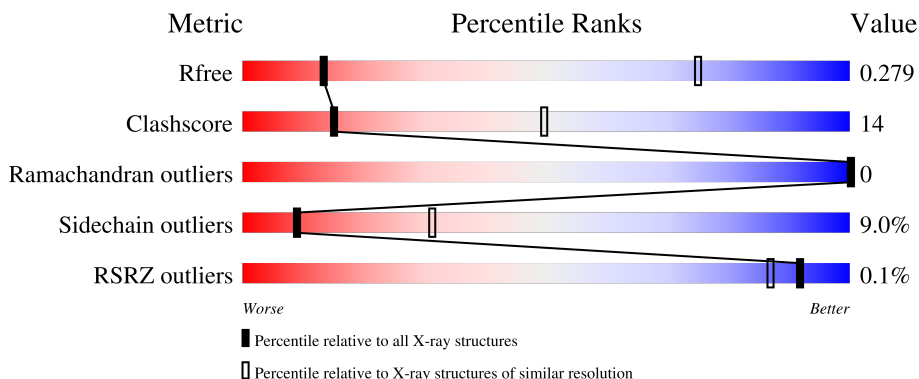
# 1 Overall quality at a glance

The following experimental techniques were used to determine the structure:

*X-RAY DIFFRACTION*

The reported resolution of this entry is 4.00 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	1082 (4.20-3.80)
Clashscore	190562	1129 (4.20-3.80)
Ramachandran outliers	187476	1064 (4.20-3.80)
Sidechain outliers	187428	1055 (4.20-3.80)
RSRZ outliers	180081	1082 (4.20-3.80)

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  $\geq 3$ , 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	139	
1	E	139	
2	B	106	
2	F	106	
3	C	133	

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Mol	Chain	Length	Quality of chain
3	G	133	
4	D	129	
4	H	129	
5	I	144	
6	J	144	

## 2 Entry composition i

There are 6 unique types of molecules in this entry. The entry contains 11974 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 Histone H3.1.

Mol	Chain	Residues	Atoms					ZeroOcc	AltConf	Trace
			Total	C	N	O	S			
1	A	98	807	508	156	139	4	0	0	0
1	E	97	801	505	155	137	4	0	0	0

There are 6 discrepancies between the modelled and reference sequences:

Chain	Residue	Modelled	Actual	Comment	Reference
A	-3	GLY	-	expression tag	UNP P68431
A	-2	SER	-	expression tag	UNP P68431
A	-1	HIS	-	expression tag	UNP P68431
E	-3	GLY	-	expression tag	UNP P68431
E	-2	SER	-	expression tag	UNP P68431
E	-1	HIS	-	expression tag	UNP P68431

- Molecule 2 is a protein called Histone H4.

Mol	Chain	Residues	Atoms					ZeroOcc	AltConf	Trace
			Total	C	N	O	S			
2	B	79	627	395	121	110	1	0	0	0
2	F	87	703	442	142	118	1	0	0	0

There are 6 discrepancies between the modelled and reference sequences:

Chain	Residue	Modelled	Actual	Comment	Reference
B	-3	GLY	-	expression tag	UNP P62805
B	-2	SER	-	expression tag	UNP P62805
B	-1	HIS	-	expression tag	UNP P62805
F	-3	GLY	-	expression tag	UNP P62805
F	-2	SER	-	expression tag	UNP P62805
F	-1	HIS	-	expression tag	UNP P62805

- Molecule 3 is a protein called Histone H2A type 1-B/E.

Mol	Chain	Residues	Atoms				ZeroOcc	AltConf	Trace
			Total	C	N	O			
3	C	105	Total	C	N	O	0	0	0
			810	511	158	141			
3	G	103	Total	C	N	O	0	0	0
			796	502	155	139			

There are 6 discrepancies between the modelled and reference sequences:

Chain	Residue	Modelled	Actual	Comment	Reference
C	-3	GLY	-	expression tag	UNP P04908
C	-2	SER	-	expression tag	UNP P04908
C	-1	HIS	-	expression tag	UNP P04908
G	-3	GLY	-	expression tag	UNP P04908
G	-2	SER	-	expression tag	UNP P04908
G	-1	HIS	-	expression tag	UNP P04908

- Molecule 4 is a protein called Histone H2B type 1-J.

Mol	Chain	Residues	Atoms					ZeroOcc	AltConf	Trace
			Total	C	N	O	S			
4	D	93	Total	C	N	O	S	0	0	0
			725	456	130	137	2			
4	H	97	Total	C	N	O	S	0	0	0
			766	480	142	142	2			

There are 6 discrepancies between the modelled and reference sequences:

Chain	Residue	Modelled	Actual	Comment	Reference
D	-3	GLY	-	expression tag	UNP P06899
D	-2	SER	-	expression tag	UNP P06899
D	-1	HIS	-	expression tag	UNP P06899
H	-3	GLY	-	expression tag	UNP P06899
H	-2	SER	-	expression tag	UNP P06899
H	-1	HIS	-	expression tag	UNP P06899

- Molecule 5 is a DNA chain called 144 mer-DNA.

Mol	Chain	Residues	Atoms					ZeroOcc	AltConf	Trace
			Total	C	N	O	P			
5	I	144	Total	C	N	O	P	0	0	0
			2969	1420	539	866	144			

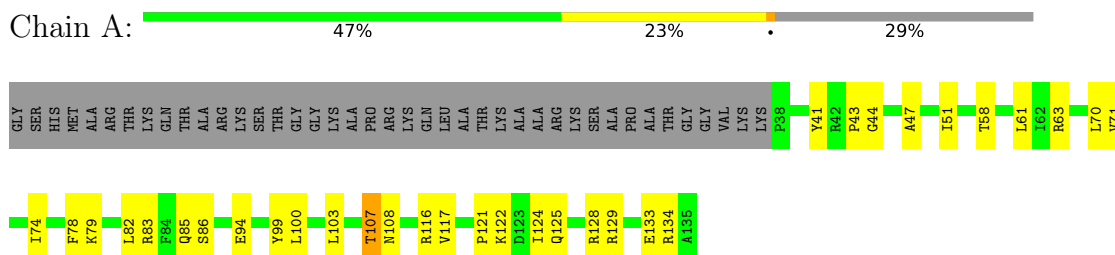
- Molecule 6 is a DNA chain called 144-mer DNA.

Mol	Chain	Residues	Atoms					ZeroOcc	AltConf	Trace
			Total	C	N	O	P			
6	J	144	2970	1421	535	870	144	0	0	0

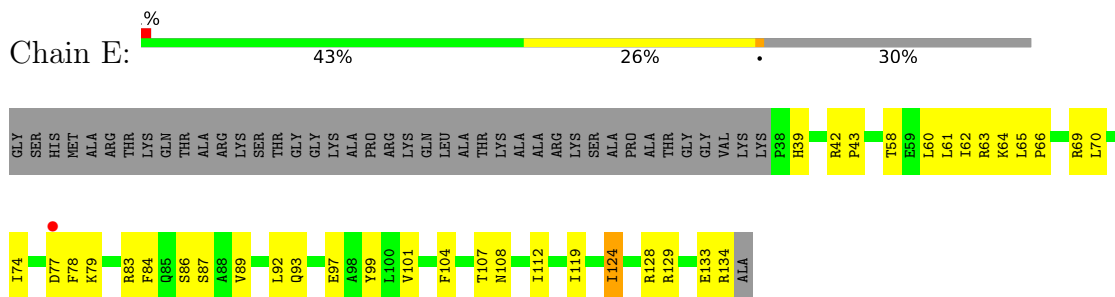
### 3 Residue-property plots

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.

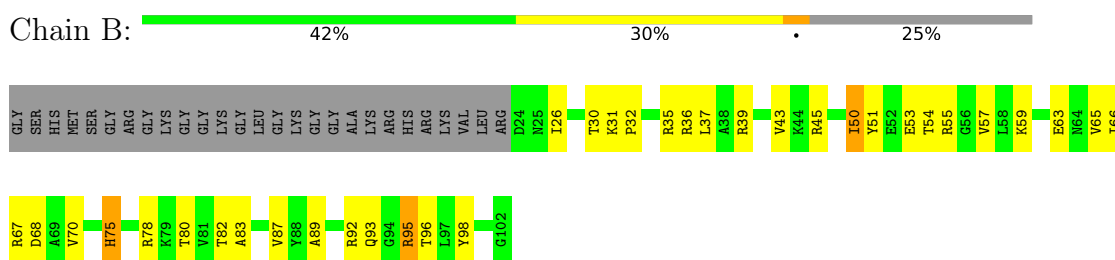
- Molecule 1: Histone H3.1



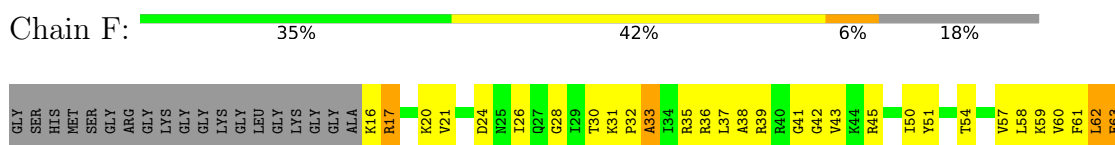
- Molecule 1: Histone H3.1

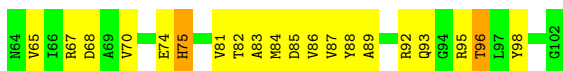


- Molecule 2: Histone H4

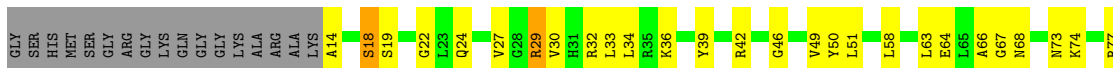


- Molecule 2: Histone H4

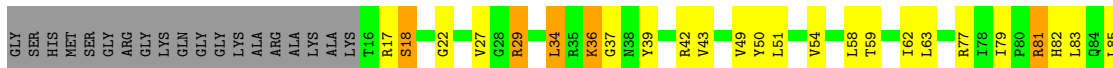




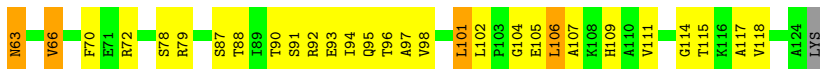
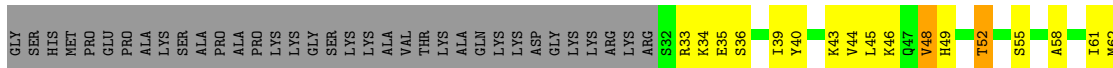
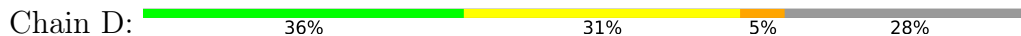
- Molecule 3: Histone H2A type 1-B/E



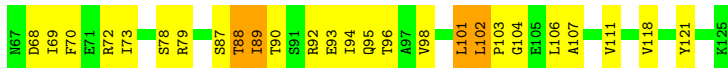
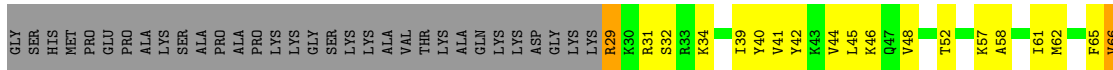
- Molecule 3: Histone H2A type 1-B/E



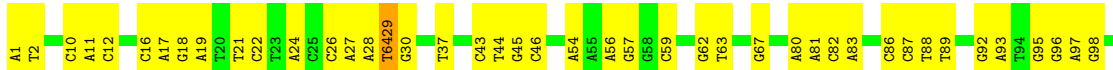
- Molecule 4: Histone H2B type 1-J

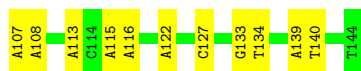


- Molecule 4: Histone H2B type 1-J



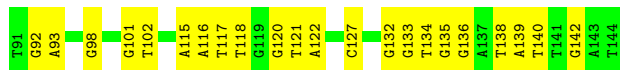
- Molecule 5: 144 mer-DNA





- Molecule 6: 144-mer DNA

Chain J: 53% 46%



## 4 Data and refinement statistics

Property	Value	Source
Space group	P 21 21 21	Depositor
Cell constants a, b, c, $\alpha$ , $\beta$ , $\gamma$	104.19Å 109.36Å 174.42Å 90.00° 90.00° 90.00°	Depositor
Resolution (Å)	33.23 – 4.00 33.23 – 4.00	Depositor EDS
% Data completeness (in resolution range)	99.1 (33.23-4.00) 95.0 (33.23-4.00)	Depositor EDS
$R_{merge}$	0.09	Depositor
$R_{sym}$	(Not available)	Depositor
$\langle I/\sigma(I) \rangle$ <sup>1</sup>	5.45 (at 4.00Å)	Xtrriage
Refinement program	PHENIX (phenix.refine: 1.9_1692)	Depositor
R, $R_{free}$	0.203 , 0.289 0.207 , 0.279	Depositor DCC
$R_{free}$ test set	870 reflections (5.01%)	wwPDB-VP
Wilson B-factor (Å <sup>2</sup> )	138.1	Xtrriage
Anisotropy	0.704	Xtrriage
Bulk solvent $k_{sol}$ (e/Å <sup>3</sup> ), $B_{sol}$ (Å <sup>2</sup> )	0.26 , 82.0	EDS
L-test for twinning <sup>2</sup>	$\langle  L  \rangle = 0.47$ , $\langle L^2 \rangle = 0.30$	Xtrriage
Estimated twinning fraction	0.025 for k,h,-l	Xtrriage
$F_o, F_c$ correlation	0.94	EDS
Total number of atoms	11974	wwPDB-VP
Average B, all atoms (Å <sup>2</sup> )	172.0	wwPDB-VP

Xtrriage's analysis on translational NCS is as follows: *The largest off-origin peak in the Patterson function is 3.58% of the height of the origin peak. No significant pseudotranslation is detected.*

<sup>1</sup>Intensities estimated from amplitudes.

<sup>2</sup>Theoretical 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

Bond lengths and bond angles in the following residue types are not validated in this section: T64

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	0.65	0/819	0.94	0/1097
1	E	0.88	2/813 (0.2%)	1.12	1/1090 (0.1%)
2	B	0.73	0/634	1.09	1/848 (0.1%)
2	F	0.96	0/711	1.20	4/948 (0.4%)
3	C	0.83	0/820	1.20	3/1107 (0.3%)
3	G	0.68	0/806	1.07	1/1089 (0.1%)
4	D	0.84	0/736	1.19	2/990 (0.2%)
4	H	0.75	0/777	1.09	2/1040 (0.2%)
5	I	0.41	0/3286	0.66	0/5067
6	J	0.40	0/3286	0.65	0/5068
All	All	0.62	2/12688 (0.0%)	0.89	14/18344 (0.1%)

All (2) bond length outliers are listed below:

Mol	Chain	Res	Type	Atoms	Z	Observed(Å)	Ideal(Å)
1	E	77	ASP	CB-CG	6.03	1.67	1.52
1	E	77	ASP	CA-C	5.35	1.60	1.52

The worst 5 of 14 bond angle outliers are listed below:

Mol	Chain	Res	Type	Atoms	Z	Observed(°)	Ideal(°)
3	C	105	GLY	N-CA-C	6.69	120.59	112.49
4	D	104	GLY	N-CA-C	6.69	123.51	111.34
4	D	48	VAL	N-CA-C	6.57	116.71	110.53
3	G	98	GLY	N-CA-C	6.32	120.29	112.64
1	E	101	VAL	N-CA-C	-6.30	104.37	110.42

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	807	0	844	31	0
1	E	801	0	839	35	0
2	B	627	0	663	29	0
2	F	703	0	755	43	0
3	C	810	0	866	36	0
3	G	796	0	848	35	0
4	D	725	0	745	36	0
4	H	766	0	797	34	0
5	I	2969	0	1639	58	0
6	J	2970	0	1641	65	0
All	All	11974	0	9637	293	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 14.

The worst 5 of 293 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:E:43:PRO:HG2	6:J:67:DG:H5'	1.45	0.99
1:E:61:LEU:HD12	2:F:37:LEU:HD23	1.50	0.94
6:J:1:DA:H2'	6:J:2:DT:H5'	1.53	0.91
1:A:117:VAL:HG13	3:G:115:LEU:HD22	1.58	0.85
3:G:77:ARG:HE	6:J:19:DA:H4'	1.42	0.83

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	96/139 (69%)	95 (99%)	1 (1%)	0	100	100
1	E	95/139 (68%)	94 (99%)	1 (1%)	0	100	100
2	B	77/106 (73%)	71 (92%)	6 (8%)	0	100	100
2	F	85/106 (80%)	79 (93%)	6 (7%)	0	100	100
3	C	103/133 (77%)	99 (96%)	4 (4%)	0	100	100
3	G	101/133 (76%)	97 (96%)	4 (4%)	0	100	100
4	D	91/129 (70%)	89 (98%)	2 (2%)	0	100	100
4	H	95/129 (74%)	92 (97%)	3 (3%)	0	100	100
All	All	743/1014 (73%)	716 (96%)	27 (4%)	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	85/113 (75%)	83 (98%)	2 (2%)	43	63
1	E	85/113 (75%)	82 (96%)	3 (4%)	32	54
2	B	64/81 (79%)	56 (88%)	8 (12%)	4	20
2	F	72/81 (89%)	62 (86%)	10 (14%)	3	17
3	C	83/102 (81%)	77 (93%)	6 (7%)	13	37
3	G	82/102 (80%)	76 (93%)	6 (7%)	13	37
4	D	79/107 (74%)	69 (87%)	10 (13%)	4	20
4	H	83/107 (78%)	71 (86%)	12 (14%)	3	16
All	All	633/806 (78%)	576 (91%)	57 (9%)	9	31

5 of 57 residues with a non-rotameric sidechain are listed below:

Mol	Chain	Res	Type
1	E	124	ILE
4	H	101	LEU
2	F	54	THR
4	H	95	GLN
4	H	66	VAL

Sometimes sidechains can be flipped to improve hydrogen bonding and reduce clashes. All (3) such sidechains are listed below:

Mol	Chain	Res	Type
2	B	64	ASN
4	D	49	HIS
3	G	112	GLN

### 5.3.3 RNA [i](#)

There are no RNA molecules in this entry.

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

2 non-standard protein/DNA/RNA residues are modelled in this entry.

In the following table, the Counts columns list the number of bonds (or angles) for which Mogul statistics could be retrieved, the number of bonds (or angles) that are observed in the model and the number of bonds (or angles) that are defined in the Chemical Component Dictionary. The Link column lists molecule types, if any, to which the group is linked. 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  $|Z| > 2$  is considered an outlier worth inspection. RMSZ is the root-mean-square of all Z scores of the bond lengths (or angles).

Mol	Type	Chain	Res	Link	Bond lengths			Bond angles		
					Counts	RMSZ	# Z  > 2	Counts	RMSZ	# Z  > 2
6	T64	J	29	6	41,44,45	2.07	5 (12%)	53,69,72	2.45	20 (37%)
5	T64	I	29	5	41,44,45	1.73	6 (14%)	53,69,72	1.96	14 (26%)

In the following table, the Chirals column lists the number of chiral outliers, the number of chiral centers analysed, the number of these observed in the model and the number defined in the Chemical Component Dictionary. Similar counts are reported in the Torsion and Rings columns. '2' means no outliers of that kind were identified.

Mol	Type	Chain	Res	Link	Chirals	Torsions	Rings
6	T64	J	29	6	-	10/22/76/77	0/3/5/5

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Mol	Type	Chain	Res	Link	Chirals	Torsions	Rings
5	T64	I	29	5	-	11/22/76/77	0/3/5/5

The worst 5 of 11 bond length outliers are listed below:

Mol	Chain	Res	Type	Atoms	Z	Observed(Å)	Ideal(Å)
6	J	29	T64	C5T-C4T	-8.13	1.36	1.47
5	I	29	T64	C5T-C4T	-5.69	1.39	1.47
6	J	29	T64	C6-C4T	-5.50	1.44	1.51
5	I	29	T64	C1'-N1	4.94	1.52	1.45
6	J	29	T64	C1'-N1	4.72	1.51	1.45

The worst 5 of 34 bond angle outliers are listed below:

Mol	Chain	Res	Type	Atoms	Z	Observed(°)	Ideal(°)
6	J	29	T64	C1R-N1T-C2T	6.66	129.26	117.83
6	J	29	T64	O4-C4-C5	-6.02	117.65	123.13
5	I	29	T64	N3-C2-N1	5.98	123.04	116.78
6	J	29	T64	C1R-N1T-C6T	-5.74	111.11	120.74
5	I	29	T64	C5T-C4T-N3T	-5.72	118.69	123.61

There are no chirality outliers.

5 of 21 torsion outliers are listed below:

Mol	Chain	Res	Type	Atoms
5	I	29	T64	C5R-O5R-PB-O3R
6	J	29	T64	C5R-O5R-PB-O3R
6	J	29	T64	O4R-C4'-C5R-O5R
6	J	29	T64	C4R-C5'-O5'-P
5	I	29	T64	O4R-C4'-C5R-O5R

There are no ring outliers.

2 monomers are involved in 7 short contacts:

Mol	Chain	Res	Type	Clashes	Symm-Clashes
6	J	29	T64	2	0
5	I	29	T64	5	0

## 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 [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, 95<sup>th</sup> 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 <sup>2</sup> )	Q<0.9
1	A	98/139 (70%)	-0.50	0 100 100	117, 147, 194, 209	0
1	E	97/139 (69%)	-0.38	1 (1%) 79 61	92, 117, 155, 182	0
2	B	79/106 (74%)	-0.44	0 100 100	111, 138, 160, 172	0
2	F	87/106 (82%)	-0.45	0 100 100	89, 107, 141, 189	0
3	C	105/133 (78%)	-0.51	0 100 100	93, 117, 156, 174	0
3	G	103/133 (77%)	-0.60	0 100 100	111, 137, 172, 184	0
4	D	93/129 (72%)	-0.53	0 100 100	99, 121, 159, 191	0
4	H	97/129 (75%)	-0.45	0 100 100	104, 133, 202, 222	0
5	I	143/144 (99%)	-0.13	0 100 100	148, 215, 248, 257	0
6	J	143/144 (99%)	-0.16	0 100 100	148, 214, 250, 271	0
All	All	1045/1302 (80%)	-0.39	1 (0%) 92 87	89, 140, 235, 271	0

All (1) RSRZ outliers are listed below:

Mol	Chain	Res	Type	RSRZ
1	E	77	ASP	2.2

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

In the following table, the Atoms column lists the number of modelled atoms in the group and the number defined in the chemical component dictionary. The B-factors column lists the minimum, median, 95<sup>th</sup> percentile and maximum values of B factors of atoms in the group. The column labelled ‘Q < 0.9’ lists the number of atoms with occupancy less than 0.9.

Mol	Type	Chain	Res	Atoms	RSCC	RSR	B-factors(Å <sup>2</sup> )	Q<0.9
5	T64	I	29	40/41	0.64	0.12	175,212,232,234	0
6	T64	J	29	40/41	0.79	0.11	186,220,233,235	0

### 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.