



wwPDB X-ray Structure Validation Summary Report ⓘ

Mar 5, 2026 – 07:57 PM UTC

PDB ID : 6JR1 / pdb_00006jr1
Title : Crystal structure of the human nucleosome phased with 16 selenium atoms
Authors : Saotome, M.; Horikoshi, N.; Urano, K.; Kujirai, T.; Yuzurihara, H.; Kurumizaka, H.; Kagawa, W.
Deposited on : 2019-04-02
Resolution : 2.40 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

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
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

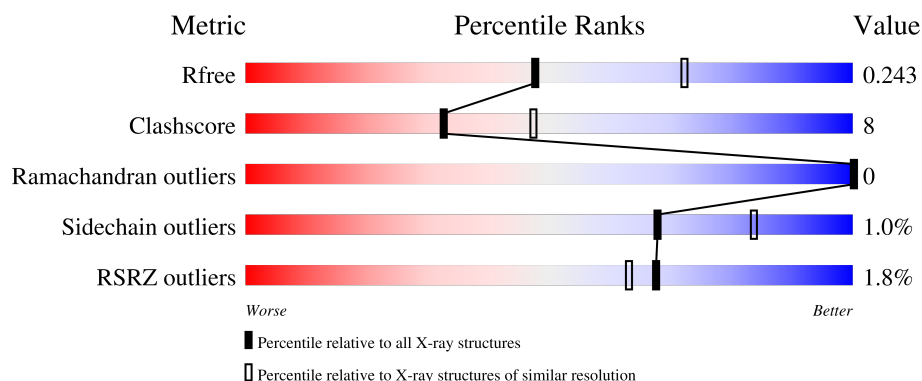
1 Overall quality at a glance

The following experimental techniques were used to determine the structure:

X-RAY DIFFRACTION

The reported resolution of this entry is 2.40 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.



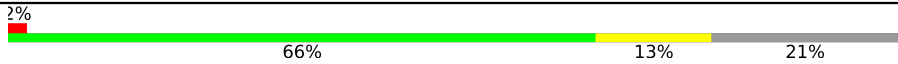
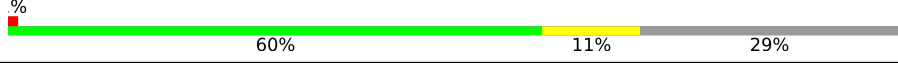
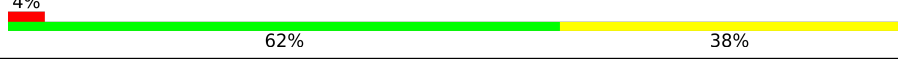
Metric	Whole archive (#Entries)	Similar resolution (#Entries, resolution range(Å))
R_{free}	180053	4912 (2.40-2.40)
Clashscore	190562	5391 (2.40-2.40)
Ramachandran outliers	187476	5320 (2.40-2.40)
Sidechain outliers	187428	5321 (2.40-2.40)
RSRZ outliers	180081	4916 (2.40-2.40)

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	139	60% 9% • 31%
1	E	139	61% 8% • 29%
2	B	106	68% 6% 26%
2	F	106	73% 8% 20%
3	C	133	74% 6% • 19%

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Mol	Chain	Length	Quality of chain
3	G	133	 2% 66% 13% 21%
4	D	129	 2% 65% 7% 28%
4	H	129	 % 60% 11% 29%
5	I	146	 4% 62% 38%
5	J	146	 62% 38%

2 Entry composition

There are 8 unique types of molecules in this entry. The entry contains 12557 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
1	A	96	Total	C	N	O	S	Se	0	0	0
			790	499	151	136	2	2			
1	E	98	Total	C	N	O	S	Se	0	0	0
			810	511	157	138	2	2			

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
2	B	78	Total	C	N	O	S	0	0	0
			622	393	120	108	1			
2	F	85	Total	C	N	O	S	0	0	0
			689	434	139	115	1			

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
3	C	108	Total	C	N	O	Se	0	0	0
			835	524	165	144	2			
3	G	105	Total	C	N	O	Se	0	0	0
			810	509	158	141	2			

There are 10 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
C	65	MSE	LEU	engineered mutation	UNP P04908
C	85	MSE	LEU	engineered mutation	UNP P04908
G	-3	GLY	-	expression tag	UNP P04908
G	-2	SER	-	expression tag	UNP P04908
G	-1	HIS	-	expression tag	UNP P04908
G	65	MSE	LEU	engineered mutation	UNP P04908
G	85	MSE	LEU	engineered mutation	UNP P04908

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

Mol	Chain	Residues	Atoms					ZeroOcc	AltConf	Trace
4	D	93	Total	C	N	O	Se	0	0	0
			725	454	130	137	4			
4	H	92	Total	C	N	O	Se	0	0	0
			719	451	129	135	4			

There are 10 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
D	101	MSE	LEU	engineered mutation	UNP P06899
D	106	MSE	LEU	engineered mutation	UNP P06899
H	-3	GLY	-	expression tag	UNP P06899
H	-2	SER	-	expression tag	UNP P06899
H	-1	HIS	-	expression tag	UNP P06899
H	101	MSE	LEU	engineered mutation	UNP P06899
H	106	MSE	LEU	engineered mutation	UNP P06899

- Molecule 5 is a DNA chain called DNA (146-MER).

Mol	Chain	Residues	Atoms					ZeroOcc	AltConf	Trace
5	I	146	Total 2990	C 1431	N 540	O 874	P 145	0	0	0
5	J	146	Total 2990	C 1431	N 540	O 874	P 145	0	0	0

- Molecule 6 is CHLORIDE ION (CCD ID: CL) (formula: Cl).

Mol	Chain	Residues	Atoms		ZeroOcc	AltConf
6	A	1	Total 1	Cl 1	0	0
6	C	1	Total 1	Cl 1	0	0
6	E	1	Total 1	Cl 1	0	0
6	G	1	Total 1	Cl 1	0	0

- Molecule 7 is MANGANESE (II) ION (CCD ID: MN) (formula: Mn).

Mol	Chain	Residues	Atoms		ZeroOcc	AltConf
7	E	1	Total 1	Mn 1	0	0
7	I	3	Total 3	Mn 3	0	0
7	J	4	Total 4	Mn 4	0	0

- Molecule 8 is water.

Mol	Chain	Residues	Atoms		ZeroOcc	AltConf
8	A	25	Total 25	O 25	0	0
8	B	29	Total 29	O 29	0	0
8	C	54	Total 54	O 54	0	0
8	D	45	Total 45	O 45	0	0
8	E	56	Total 56	O 56	0	0
8	F	52	Total 52	O 52	0	0

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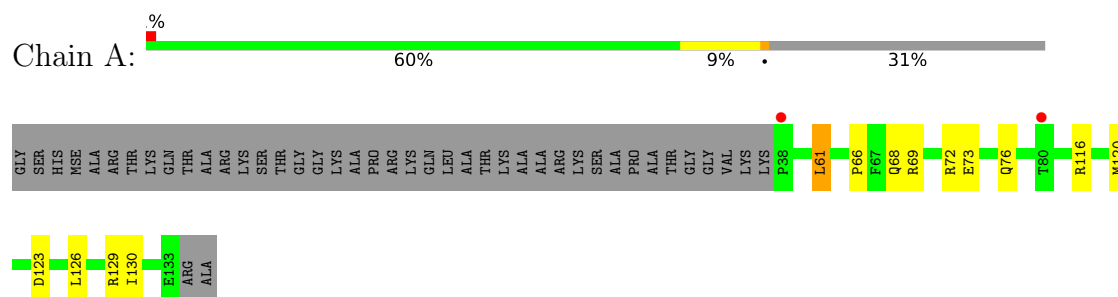
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Mol	Chain	Residues	Atoms		ZeroOcc	AltConf
8	G	44	Total 44	O 44	0	0
8	H	20	Total 20	O 20	0	0
8	I	118	Total 118	O 118	0	0
8	J	122	Total 122	O 122	0	0

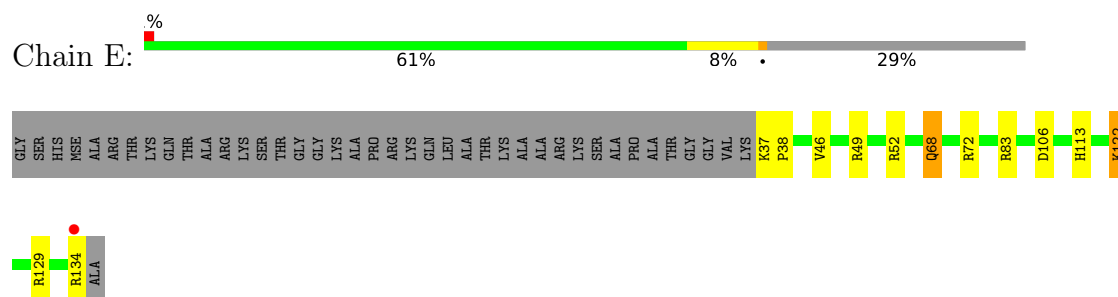
3 Residue-property plots [i](#)

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.

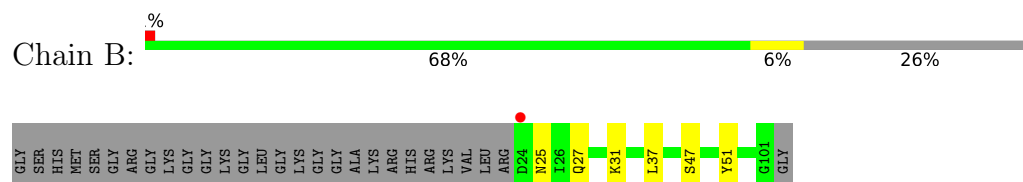
• Molecule 1: Histone H3.1



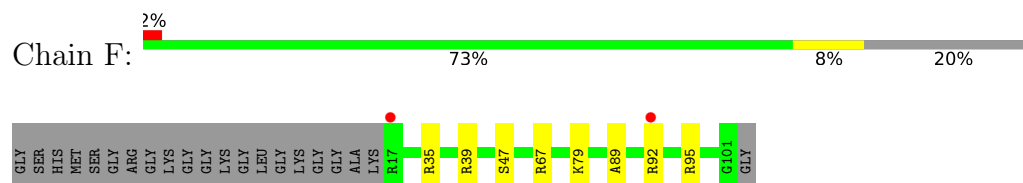
• Molecule 1: Histone H3.1



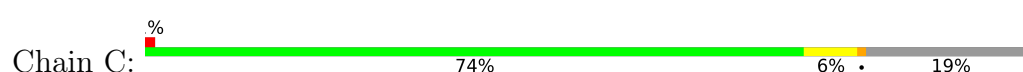
• Molecule 2: Histone H4

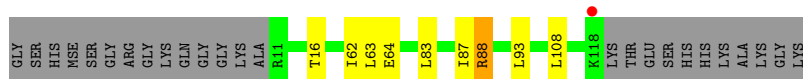


• Molecule 2: Histone H4

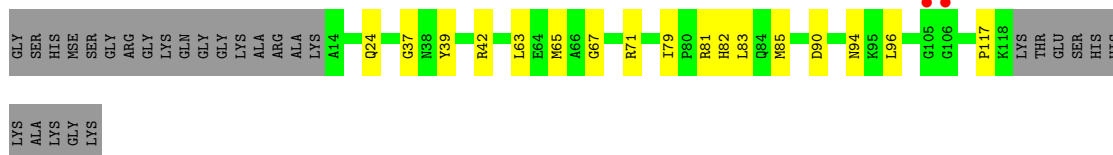


• Molecule 3: Histone H2A type 1-B/E

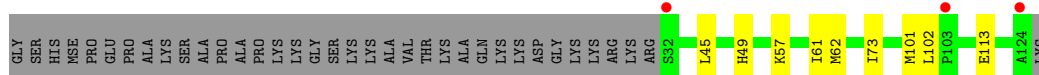




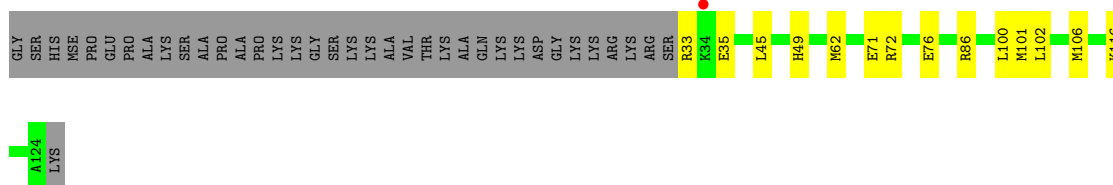
- Molecule 3: Histone H2A type 1-B/E



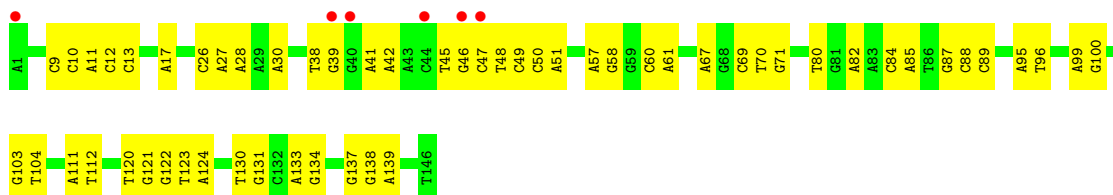
- Molecule 4: Histone H2B type 1-J



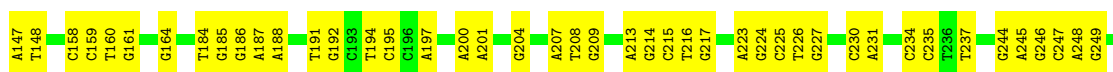
- Molecule 4: Histone H2B type 1-J



- Molecule 5: DNA (146-MER)



- Molecule 5: DNA (146-MER)



C254	A255	T266	G267	G268	T269	A270	G271	A272	C275	T276	G277	C278	A279	T282
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4 Data and refinement statistics

Property	Value	Source
Space group	P 21 21 21	Depositor
Cell constants a, b, c, α , β , γ	99.46Å 108.54Å 170.46Å 90.00° 90.00° 90.00°	Depositor
Resolution (Å)	47.74 – 2.40 47.74 – 2.40	Depositor EDS
% Data completeness (in resolution range)	100.0 (47.74-2.40) 100.0 (47.74-2.40)	Depositor EDS
R_{merge}	0.13	Depositor
R_{sym}	(Not available)	Depositor
$\langle I/\sigma(I) \rangle$ ¹	2.38 (at 2.39Å)	Xtriage
Refinement program	PHENIX (1.14_3260: ???)	Depositor
R, R_{free}	0.209 , 0.243 0.209 , 0.243	Depositor DCC
R_{free} test set	3598 reflections (4.80%)	wwPDB-VP
Wilson B-factor (Å ²)	38.4	Xtriage
Anisotropy	0.326	Xtriage
Bulk solvent k_{sol} (e/Å ³), B_{sol} (Å ²)	0.31 , 39.9	EDS
L-test for twinning ²	$\langle L \rangle = 0.50$, $\langle L^2 \rangle = 0.33$	Xtriage
Estimated twinning fraction	No twinning to report.	Xtriage
F_o, F_c correlation	0.94	EDS
Total number of atoms	12557	wwPDB-VP
Average B, all atoms (Å ²)	45.0	wwPDB-VP

Xtriage's analysis on translational NCS is as follows: *The largest off-origin peak in the Patterson function is 2.61% 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

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

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	0.18	0/800	0.40	0/1070
1	E	0.20	0/820	0.44	0/1096
2	B	0.20	0/629	0.44	0/843
2	F	0.28	0/697	0.47	0/932
3	C	0.19	0/843	0.41	0/1131
3	G	0.20	0/818	0.41	0/1099
4	D	0.20	0/732	0.40	0/976
4	H	0.19	0/726	0.41	0/968
5	I	0.29	0/3354	0.58	0/5175
5	J	0.30	0/3354	0.62	0/5175
All	All	0.26	0/12773	0.53	0/18465

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	790	0	826	15	1
1	E	810	0	851	17	0
2	B	622	0	660	6	0

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Mol	Chain	Non-H	H(model)	H(added)	Clashes	Symm-Clashes
2	F	689	0	739	12	0
3	C	835	0	893	8	0
3	G	810	0	862	13	0
4	D	725	0	741	9	0
4	H	719	0	736	19	0
5	I	2990	0	1652	54	1
5	J	2990	0	1652	51	0
6	A	1	0	0	0	0
6	C	1	0	0	0	0
6	E	1	0	0	0	0
6	G	1	0	0	0	0
7	E	1	0	0	0	0
7	I	3	0	0	0	0
7	J	4	0	0	0	0
8	A	25	0	0	0	0
8	B	29	0	0	1	0
8	C	54	0	0	0	0
8	D	45	0	0	1	0
8	E	56	0	0	6	0
8	F	52	0	0	3	0
8	G	44	0	0	5	0
8	H	20	0	0	1	0
8	I	118	0	0	17	1
8	J	122	0	0	9	1
All	All	12557	0	9612	171	2

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 8.

The worst 5 of 171 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)
5:I:137:DG:N7	8:I:301:HOH:O	1.96	0.98
5:J:192:DG:N7	8:J:402:HOH:O	1.98	0.95
5:I:47:DC:H2''	5:I:48:DT:H5''	1.56	0.88
5:J:207:DA:OP2	8:J:401:HOH:O	1.91	0.88
2:F:92:ARG:HH22	4:H:101:MSE:SE	2.06	0.87

All (2) symmetry-related close contacts are listed below. The label for Atom-2 includes the symmetry operator and encoded unit-cell translations to be applied.

Atom-1	Atom-2	Interatomic distance (Å)	Clash overlap (Å)
8:I:317:HOH:O	8:J:515:HOH:O[1_655]	2.01	0.19
1:A:76:GLN:NE2	5:I:139:DA:OP1[3_746]	2.19	0.01

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	94/139 (68%)	94 (100%)	0	0	100	100
1	E	96/139 (69%)	96 (100%)	0	0	100	100
2	B	76/106 (72%)	74 (97%)	2 (3%)	0	100	100
2	F	83/106 (78%)	81 (98%)	2 (2%)	0	100	100
3	C	106/133 (80%)	104 (98%)	2 (2%)	0	100	100
3	G	103/133 (77%)	101 (98%)	2 (2%)	0	100	100
4	D	91/129 (70%)	90 (99%)	1 (1%)	0	100	100
4	H	90/129 (70%)	89 (99%)	1 (1%)	0	100	100
All	All	739/1014 (73%)	729 (99%)	10 (1%)	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	84/110 (76%)	83 (99%)	1 (1%)	63	81

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Mol	Chain	Analysed	Rotameric	Outliers	Percentiles	
1	E	86/110 (78%)	84 (98%)	2 (2%)	44	66
2	B	64/81 (79%)	63 (98%)	1 (2%)	55	76
2	F	71/81 (88%)	70 (99%)	1 (1%)	59	79
3	C	85/99 (86%)	84 (99%)	1 (1%)	63	81
3	G	83/99 (84%)	83 (100%)	0	100	100
4	D	79/102 (78%)	79 (100%)	0	100	100
4	H	78/102 (76%)	78 (100%)	0	100	100
All	All	630/784 (80%)	624 (99%)	6 (1%)	68	84

5 of 6 residues with a non-rotameric sidechain are listed below:

Mol	Chain	Res	Type
1	E	68	GLN
1	E	122	LYS
2	F	47	SER
2	B	47	SER
1	A	61	LEU

Sometimes sidechains can be flipped to improve hydrogen bonding and reduce clashes. All (5) such sidechains are listed below:

Mol	Chain	Res	Type
3	C	38	ASN
4	D	95	GLN
3	G	104	GLN
4	H	49	HIS
4	H	95	GLN

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 [i](#)

There are no oligosaccharides in this entry.

5.6 Ligand geometry [i](#)

Of 12 ligands modelled in this entry, 12 are monoatomic - leaving 0 for Mogul analysis.

There are no bond length outliers.

There are no bond angle outliers.

There are no chirality outliers.

There are no torsion outliers.

There are no ring outliers.

No monomer is involved in short contacts.

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	94/139 (67%)	0.00	2 (2%) 63 59	23, 35, 58, 70	0
1	E	96/139 (69%)	-0.34	1 (1%) 79 76	18, 28, 44, 68	0
2	B	78/106 (73%)	-0.09	1 (1%) 75 71	23, 33, 46, 73	0
2	F	85/106 (80%)	-0.20	2 (2%) 59 55	19, 25, 41, 84	0
3	C	106/133 (79%)	-0.06	1 (0%) 81 78	21, 30, 54, 78	0
3	G	103/133 (77%)	-0.09	2 (1%) 66 62	22, 33, 54, 68	0
4	D	89/129 (68%)	-0.06	3 (3%) 48 44	20, 28, 51, 62	0
4	H	88/129 (68%)	-0.14	1 (1%) 78 74	21, 31, 49, 62	0
5	I	146/146 (100%)	0.32	6 (4%) 41 37	32, 54, 99, 111	0
5	J	146/146 (100%)	0.35	0 100 100	33, 54, 99, 107	0
All	All	1031/1306 (78%)	0.01	19 (1%) 67 63	18, 35, 76, 111	0

The worst 5 of 19 RSRZ outliers are listed below:

Mol	Chain	Res	Type	RSRZ
2	F	92	ARG	3.9
1	A	38	PRO	3.7
5	I	1	DA	3.4
4	D	124	ALA	3.1
4	D	103	PRO	3.1

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 [i](#)

There are no oligosaccharides in this entry.

6.4 Ligands [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, 95th 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($\text{\AA}^2$)	Q<0.9
7	MN	I	203	1/1	0.84	0.10	90,90,90,90	0
7	MN	J	303	1/1	0.94	0.06	62,62,62,62	0
7	MN	J	301	1/1	0.96	0.07	75,75,75,75	0
6	CL	A	201	1/1	0.97	0.12	49,49,49,49	0
6	CL	G	201	1/1	0.98	0.05	31,31,31,31	0
6	CL	E	202	1/1	0.98	0.04	47,47,47,47	0
7	MN	J	304	1/1	0.98	0.04	52,52,52,52	0
7	MN	E	201	1/1	0.99	0.02	26,26,26,26	0
7	MN	J	302	1/1	0.99	0.03	41,41,41,41	0
7	MN	I	201	1/1	0.99	0.06	63,63,63,63	0
6	CL	C	201	1/1	0.99	0.03	33,33,33,33	0
7	MN	I	202	1/1	1.00	0.03	44,44,44,44	0

6.5 Other polymers [i](#)

There are no such residues in this entry.