



wwPDB X-ray Structure Validation Summary Report ⓘ

Mar 5, 2026 – 08:12 PM UTC

PDB ID : 1P3O / pdb_00001p3o
Title : Crystallographic Studies of Nucleosome Core Particles containing Histone 'Sin' Mutants
Authors : Muthurajan, U.M.; Bao, Y.; Forsberg, L.J.; Edayathumangalam, R.S.; Dyer, P.N.; White, C.L.; Luger, K.
Deposited on : 2003-04-17
Resolution : 2.75 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
Xtriage (Phenix)	:	NOT EXECUTED
EDS	:	NOT EXECUTED
Percentile statistics	:	20250101.v01 (using entries in the PDB archive January 1st 2025)
Ideal geometry (proteins)	:	Engh & Huber (2001)
Ideal geometry (DNA, RNA)	:	Parkinson et al. (1996)
Validation Pipeline (wwPDB-VP)	:	2.49

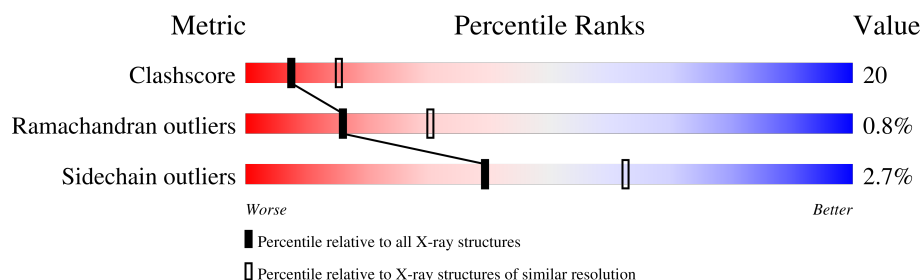
1 Overall quality at a glance

The following experimental techniques were used to determine the structure:

X-RAY DIFFRACTION

The reported resolution of this entry is 2.75 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	190562	1044 (2.76-2.76)
Ramachandran outliers	187476	1024 (2.76-2.76)
Sidechain outliers	187428	1024 (2.76-2.76)

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	I	146	
1	J	146	
2	A	135	
2	E	135	
3	B	102	
3	F	102	
4	C	129	
4	G	129	

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Mol	Chain	Length	Quality of chain
5	D	125	 48% 22% • 26%
5	H	125	 52% 19% • 26%

2 Entry composition [i](#)

There are 6 unique types of molecules in this entry. The entry contains 12182 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 DNA chain called Palindromic 146bp Human Alpha-Satellite DNA fragment.

Mol	Chain	Residues	Atoms					ZeroOcc	AltConf	Trace
1	I	146	Total	C	N	O	P	0	0	0
			2990	1430	541	874	145			
1	J	146	Total	C	N	O	P	0	0	0
			2990	1430	541	874	145			

- Molecule 2 is a protein called Histone H3.

Mol	Chain	Residues	Atoms					ZeroOcc	AltConf	Trace
2	A	98	Total	C	N	O	S	0	0	0
			808	509	156	140	3			
2	E	97	Total	C	N	O	S	0	0	0
			801	504	155	139	3			

There are 6 discrepancies between the modelled and reference sequences:

Chain	Residue	Modelled	Actual	Comment	Reference
A	434	GLU	GLY	conflict	UNP Q7ZT64
A	435	SER	VAL	conflict	UNP Q7ZT64
A	502	ALA	GLY	conflict	UNP Q7ZT64
E	634	GLU	GLY	conflict	UNP Q7ZT64
E	635	SER	VAL	conflict	UNP Q7ZT64
E	702	ALA	GLY	conflict	UNP Q7ZT64

- Molecule 3 is a protein called Histone H4.

Mol	Chain	Residues	Atoms					ZeroOcc	AltConf	Trace
3	B	82	Total	C	N	O	S	0	0	0
			651	410	127	113	1			
3	F	79	Total	C	N	O	S	0	0	0
			625	393	121	110	1			

There are 2 discrepancies between the modelled and reference sequences:

Chain	Residue	Modelled	Actual	Comment	Reference
B	43	ALA	VAL	conflict	UNP P62799
F	243	ALA	VAL	conflict	UNP P62799

- Molecule 4 is a protein called Histone H2A.

Mol	Chain	Residues	Atoms				ZeroOcc	AltConf	Trace
4	C	107	Total	C	N	O	0	0	0
			825	520	161	144			
4	G	106	Total	C	N	O	0	0	0
			818	516	160	142			

There are 48 discrepancies between the modelled and reference sequences:

Chain	Residue	Modelled	Actual	Comment	Reference
C	814	ALA	SER	conflict	UNP Q7ZT66
C	867	GLY	TRP	conflict	UNP Q7ZT66
C	868	ASN	GLU	conflict	UNP Q7ZT66
C	869	ALA	ARG	conflict	UNP Q7ZT66
C	870	ALA	LEU	conflict	UNP Q7ZT66
C	871	ARG	PRO	conflict	UNP Q7ZT66
C	872	ASP	GLU	conflict	UNP Q7ZT66
C	873	ASN	ILE	conflict	UNP Q7ZT66
C	874	LYS	TRP	conflict	UNP Q7ZT66
C	876	THR	ARG	conflict	UNP Q7ZT66
C	877	ARG	PRO	conflict	UNP Q7ZT66
C	878	ILE	VAL	conflict	UNP Q7ZT66
C	879	ILE	LEU	conflict	UNP Q7ZT66
C	880	PRO	SER	conflict	UNP Q7ZT66
C	881	ARG	PRO	conflict	UNP Q7ZT66
C	882	HIS	GLY	conflict	UNP Q7ZT66
C	883	LEU	TRP	conflict	UNP Q7ZT66
C	884	GLN	CYS	conflict	UNP Q7ZT66
C	885	LEU	ASN	conflict	UNP Q7ZT66
C	886	ALA	SER	conflict	UNP Q7ZT66
C	887	VAL	LEU	conflict	UNP Q7ZT66
C	888	ARG	CYS	conflict	UNP Q7ZT66
C	923	ALA	SER	conflict	UNP Q7ZT66
C	926	ALA	THR	conflict	UNP Q7ZT66
G	1014	ALA	SER	conflict	UNP Q7ZT66
G	1067	GLY	TRP	conflict	UNP Q7ZT66
G	1068	ASN	GLU	conflict	UNP Q7ZT66
G	1069	ALA	ARG	conflict	UNP Q7ZT66
G	1070	ALA	LEU	conflict	UNP Q7ZT66

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Chain	Residue	Modelled	Actual	Comment	Reference
G	1071	ARG	PRO	conflict	UNP Q7ZT66
G	1072	ASP	GLU	conflict	UNP Q7ZT66
G	1073	ASN	ILE	conflict	UNP Q7ZT66
G	1074	LYS	TRP	conflict	UNP Q7ZT66
G	1076	THR	ARG	conflict	UNP Q7ZT66
G	1077	ARG	PRO	conflict	UNP Q7ZT66
G	1078	ILE	VAL	conflict	UNP Q7ZT66
G	1079	ILE	LEU	conflict	UNP Q7ZT66
G	1080	PRO	SER	conflict	UNP Q7ZT66
G	1081	ARG	PRO	conflict	UNP Q7ZT66
G	1082	HIS	GLY	conflict	UNP Q7ZT66
G	1083	LEU	TRP	conflict	UNP Q7ZT66
G	1084	GLN	CYS	conflict	UNP Q7ZT66
G	1085	LEU	ASN	conflict	UNP Q7ZT66
G	1086	ALA	SER	conflict	UNP Q7ZT66
G	1087	VAL	LEU	conflict	UNP Q7ZT66
G	1088	ARG	CYS	conflict	UNP Q7ZT66
G	1123	ALA	SER	conflict	UNP Q7ZT66
G	1126	ALA	THR	conflict	UNP Q7ZT66

- Molecule 5 is a protein called Histone H2B.

Mol	Chain	Residues	Atoms					ZeroOcc	AltConf	Trace
5	D	92	Total	C	N	O	S	0	0	0
			718	453	127	136	2			
5	H	92	Total	C	N	O	S	0	0	0
			718	453	127	136	2			

There are 8 discrepancies between the modelled and reference sequences:

Chain	Residue	Modelled	Actual	Comment	Reference
D	1219	GLN	PRO	conflict	UNP P02281
D	1242	LEU	MET	conflict	UNP P02281
D	1257	SER	GLY	conflict	UNP P02281
D	1266	VAL	ILE	conflict	UNP P02281
H	1419	GLN	PRO	conflict	UNP P02281
H	1442	LEU	MET	conflict	UNP P02281
H	1457	SER	GLY	conflict	UNP P02281
H	1466	VAL	ILE	conflict	UNP P02281

- Molecule 6 is water.

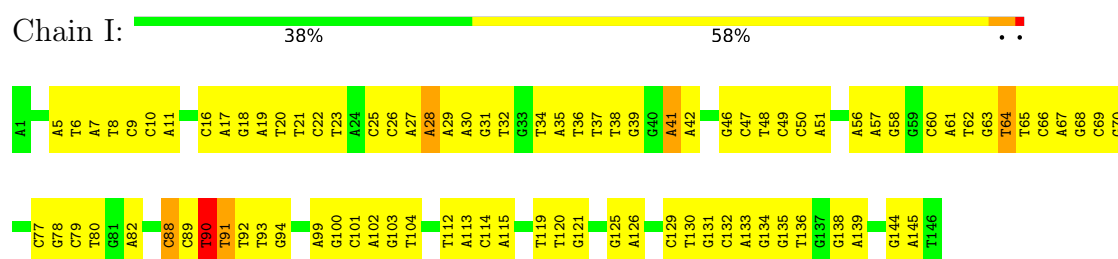
Mol	Chain	Residues	Atoms		ZeroOcc	AltConf
6	I	40	Total 40	O 40	0	0
6	J	38	Total 38	O 38	0	0
6	A	14	Total 14	O 14	0	0
6	B	12	Total 12	O 12	0	0
6	C	29	Total 29	O 29	0	0
6	D	19	Total 19	O 19	0	0
6	E	30	Total 30	O 30	0	0
6	F	28	Total 28	O 28	0	0
6	G	16	Total 16	O 16	0	0
6	H	12	Total 12	O 12	0	0

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. 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.

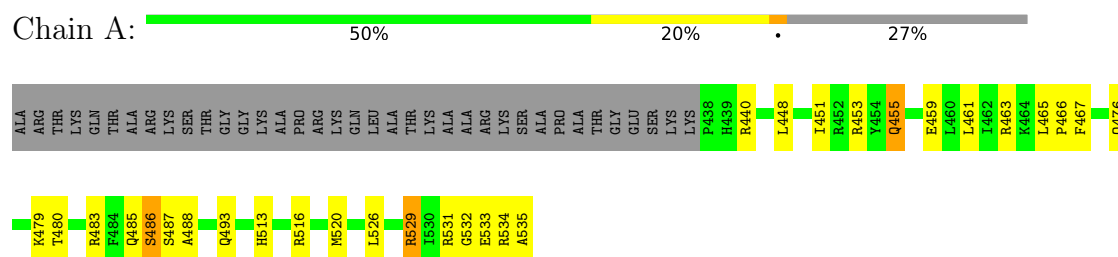
• Molecule 1: Palindromic 146bp Human Alpha-Satellite DNA fragment



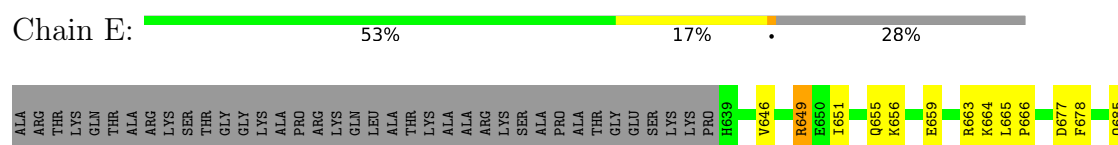
• Molecule 1: Palindromic 146bp Human Alpha-Satellite DNA fragment



• Molecule 2: Histone H3



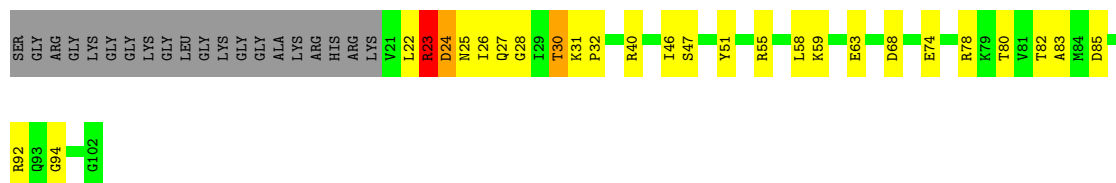
• Molecule 2: Histone H3





• Molecule 3: Histone H4

Chain B: 54% 24% 20%



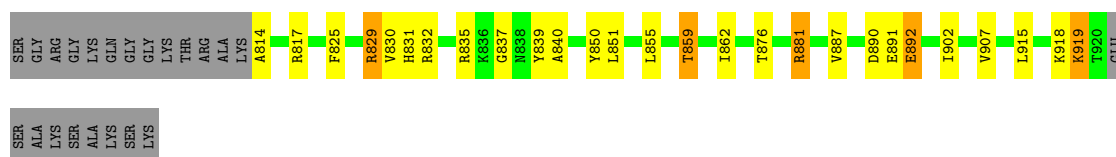
• Molecule 3: Histone H4

Chain F: 52% 25% 23%



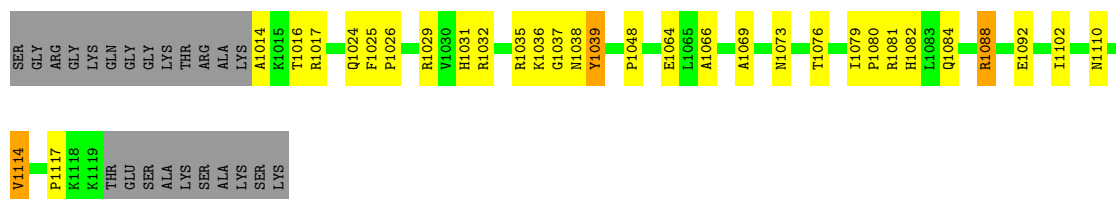
• Molecule 4: Histone H2A

Chain C: 62% 17% 17%



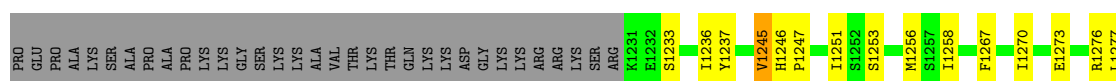
• Molecule 4: Histone H2A

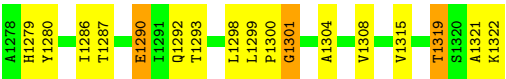
Chain G: 58% 22% 18%



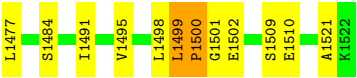
• Molecule 5: Histone H2B

Chain D: 48% 22% 26%





● Molecule 5: Histone H2B



4 Data and refinement statistics

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

Property	Value	Source
Space group	P 21 21 21	Depositor
Cell constants a, b, c, α , β , γ	105.97Å 109.83Å 181.67Å 90.00° 90.00° 90.00°	Depositor
Resolution (Å)	50.00 – 2.75	Depositor
% Data completeness (in resolution range)	95.3 (50.00-2.75)	Depositor
R_{merge}	0.08	Depositor
R_{sym}	(Not available)	Depositor
Refinement program	CNS	Depositor
R, R_{free}	0.224 , 0.276	Depositor
Estimated twinning fraction	No twinning to report.	Xtriage
Total number of atoms	12182	wwPDB-VP
Average B, all atoms (Å ²)	69.0	wwPDB-VP

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	I	0.42	1/3354 (0.0%)	0.86	8/5175 (0.2%)
1	J	0.41	0/3354	0.87	8/5175 (0.2%)
2	A	0.68	0/820	1.03	3/1099 (0.3%)
2	E	0.76	0/812	1.06	4/1088 (0.4%)
3	B	0.68	0/658	1.20	4/880 (0.5%)
3	F	0.81	0/632	1.16	7/845 (0.8%)
4	C	0.69	0/835	1.04	1/1127 (0.1%)
4	G	0.62	0/828	0.98	3/1117 (0.3%)
5	D	0.79	2/729 (0.3%)	1.12	4/980 (0.4%)
5	H	0.66	0/729	1.05	4/980 (0.4%)
All	All	0.57	3/12751 (0.0%)	0.96	46/18466 (0.2%)

Chiral center outliers are detected by calculating the chiral volume of a chiral center and verifying if the center is modelled as a planar moiety or with the opposite hand. A planarity outlier is detected by checking planarity of atoms in a peptide group, atoms in a mainchain group or atoms of a sidechain that are expected to be planar.

Mol	Chain	#Chirality outliers	#Planarity outliers
1	I	0	3
1	J	0	1
All	All	0	4

All (3) bond length outliers are listed below:

Mol	Chain	Res	Type	Atoms	Z	Observed(Å)	Ideal(Å)
1	I	65	DT	P-OP1	6.43	1.61	1.48
5	D	1245	VAL	C-O	5.34	1.29	1.24
5	D	1304	ALA	CA-CB	-5.20	1.45	1.53

The worst 5 of 46 bond angle outliers are listed below:

Mol	Chain	Res	Type	Atoms	Z	Observed(°)	Ideal(°)
3	B	23	ARG	N-CA-C	13.40	130.76	112.93

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Mol	Chain	Res	Type	Atoms	Z	Observed(°)	Ideal(°)
1	I	64	DT	C2'-C3'-O3'	-12.34	92.98	111.50
1	J	237	DT	C4'-C3'-O3'	11.43	127.15	110.00
1	J	237	DT	OP2-P-O3'	-10.59	76.23	108.00
3	B	46	ILE	N-CA-C	8.00	119.40	107.80

There are no chirality outliers.

All (4) planarity outliers are listed below:

Mol	Chain	Res	Type	Group
1	I	28	DA	Sidechain
1	I	88	DC	Sidechain
1	I	90	DT	Sidechain
1	J	158	DC	Sidechain

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	I	2990	0	1651	135	0
1	J	2990	0	1651	150	0
2	A	808	0	846	30	0
2	E	801	0	838	22	0
3	B	651	0	692	28	0
3	F	625	0	659	19	0
4	C	825	0	884	30	0
4	G	818	0	877	34	0
5	D	718	0	740	23	1
5	H	718	0	740	22	0
6	A	14	0	0	0	0
6	B	12	0	0	0	0
6	C	29	0	0	1	0
6	D	19	0	0	0	0
6	E	30	0	0	7	1
6	F	28	0	0	2	0
6	G	16	0	0	2	0
6	H	12	0	0	0	0
6	I	40	0	0	3	0

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Mol	Chain	Non-H	H(model)	H(added)	Clashes	Symm-Clashes
6	J	38	0	0	5	0
All	All	12182	0	9578	433	1

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 20.

The worst 5 of 433 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:J:264:DT:H2''	1:J:265:DT:H71	1.26	1.15
3:F:287:VAL:HG11	3:F:302:GLY:HA3	1.34	1.07
1:I:27:DA:H4'	1:I:28:DA:OP1	1.64	0.95
3:B:23:ARG:NH1	3:B:28:GLY:HA2	1.82	0.95
1:I:79:DC:H42	1:J:214:DG:H1	1.04	0.94

All (1) 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)
5:D:1245:VAL:O	6:E:1:HOH:O[3_654]	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	
2	A	96/135 (71%)	95 (99%)	1 (1%)	0	100	100
2	E	95/135 (70%)	93 (98%)	1 (1%)	1 (1%)	11	22
3	B	80/102 (78%)	77 (96%)	2 (2%)	1 (1%)	9	18
3	F	77/102 (76%)	75 (97%)	2 (3%)	0	100	100
4	C	105/129 (81%)	100 (95%)	5 (5%)	0	100	100

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Mol	Chain	Analysed	Favoured	Allowed	Outliers	Percentiles	
4	G	104/129 (81%)	98 (94%)	5 (5%)	1 (1%)	12	24
5	D	90/125 (72%)	86 (96%)	3 (3%)	1 (1%)	11	22
5	H	90/125 (72%)	85 (94%)	3 (3%)	2 (2%)	5	10
All	All	737/982 (75%)	709 (96%)	22 (3%)	6 (1%)	16	30

5 of 6 Ramachandran outliers are listed below:

Mol	Chain	Res	Type
3	B	24	ASP
5	D	1301	GLY
2	E	734	ARG
5	H	1501	GLY
5	H	1521	ALA

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	
2	A	85/111 (77%)	81 (95%)	4 (5%)	23	45
2	E	84/111 (76%)	82 (98%)	2 (2%)	43	65
3	B	66/77 (86%)	65 (98%)	1 (2%)	57	74
3	F	63/77 (82%)	63 (100%)	0	100	100
4	C	85/100 (85%)	80 (94%)	5 (6%)	18	33
4	G	84/100 (84%)	83 (99%)	1 (1%)	63	78
5	D	78/105 (74%)	76 (97%)	2 (3%)	40	63
5	H	78/105 (74%)	76 (97%)	2 (3%)	40	63
All	All	623/786 (79%)	606 (97%)	17 (3%)	39	62

5 of 17 residues with a non-rotameric sidechain are listed below:

Mol	Chain	Res	Type
4	G	1088	ARG

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Mol	Chain	Res	Type
5	H	1500	PRO
4	C	876	THR
4	C	881	ARG
4	C	919	LYS

Sometimes sidechains can be flipped to improve hydrogen bonding and reduce clashes. 5 of 10 such sidechains are listed below:

Mol	Chain	Res	Type
4	G	1038	ASN
4	G	1073	ASN
4	G	1094	ASN
5	D	1292	GLN
2	E	713	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 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

6.1 Protein, DNA and RNA chains

EDS was not executed - this section is therefore empty.

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

EDS was not executed - this section is therefore empty.

6.3 Carbohydrates

EDS was not executed - this section is therefore empty.

6.4 Ligands

EDS was not executed - this section is therefore empty.

6.5 Other polymers

EDS was not executed - this section is therefore empty.