



# wwPDB X-ray Structure Validation Summary Report ⓘ

May 13, 2020 – 02:44 am BST

PDB ID : 2HK0  
Title : Crystal structure of D-psicose 3-epimerase (DPEase) in the absence of substrate  
Authors : Kim, K.; Kim, H.J.; Oh, D.K.; Cha, S.S.; Rhee, S.  
Deposited on : 2006-07-03  
Resolution : 2.00 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.

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

MolProbity : 4.02b-467  
Mogul : 1.8.5 (274361), CSD as541be (2020)  
Xtriage (Phenix) : 1.13  
EDS : 2.11  
Percentile statistics : 20191225.v01 (using entries in the PDB archive December 25th 2019)  
Refmac : 5.8.0158  
CCP4 : 7.0.044 (Gargrove)  
Ideal geometry (proteins) : Engh & Huber (2001)  
Ideal geometry (DNA, RNA) : Parkinson et al. (1996)  
Validation Pipeline (wwPDB-VP) : 2.11

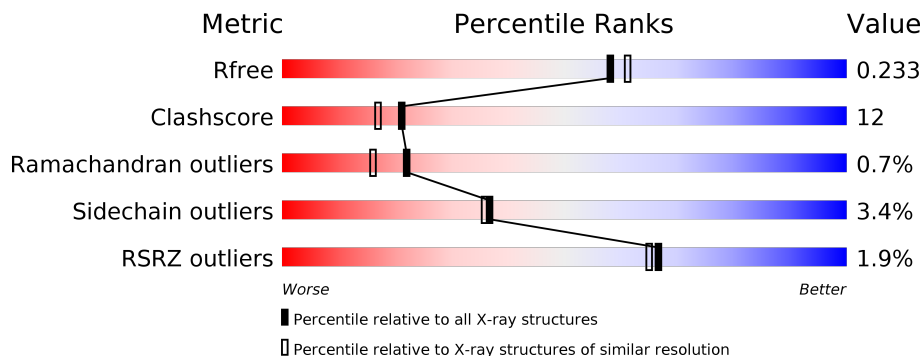
# 1 Overall quality at a glance

The following experimental techniques were used to determine the structure:

*X-RAY DIFFRACTION*

The reported resolution of this entry is 2.00 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))
$R_{free}$	130704	8085 (2.00-2.00)
Clashscore	141614	9178 (2.00-2.00)
Ramachandran outliers	138981	9054 (2.00-2.00)
Sidechain outliers	138945	9053 (2.00-2.00)
RSRZ outliers	127900	7900 (2.00-2.00)

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 on 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	309	 2% 74% 18% • 6%
1	B	309	 3% 76% 15% • 6%
1	C	309	 % 72% 19% • 6%
1	D	309	 2% 76% 14% • 6%

## 2 Entry composition [i](#)

There are 2 unique types of molecules in this entry. The entry contains 9675 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 D-PSICOSE 3-EPIMERASE.

Mol	Chain	Residues	Atoms						ZeroOcc	AltConf	Trace
			Total	C	N	O	S	Se			
1	A	289	2229	1413	390	419	1	6	0	0	0
1	B	289	2229	1413	390	419	1	6	0	0	0
1	C	289	2229	1413	390	419	1	6	0	0	0
1	D	289	2229	1413	390	419	1	6	0	0	0

There are 104 discrepancies between the modelled and reference sequences:

Chain	Residue	Modelled	Actual	Comment	Reference
A	-19	MSE	-	CLONING ARTIFACT	UNP Q8U6Q7
A	-18	GLY	-	CLONING ARTIFACT	UNP Q8U6Q7
A	-17	SER	-	CLONING ARTIFACT	UNP Q8U6Q7
A	-16	SER	-	CLONING ARTIFACT	UNP Q8U6Q7
A	-15	HIS	-	CLONING ARTIFACT	UNP Q8U6Q7
A	-14	HIS	-	CLONING ARTIFACT	UNP Q8U6Q7
A	-13	HIS	-	CLONING ARTIFACT	UNP Q8U6Q7
A	-12	HIS	-	CLONING ARTIFACT	UNP Q8U6Q7
A	-11	HIS	-	CLONING ARTIFACT	UNP Q8U6Q7
A	-10	SER	-	CLONING ARTIFACT	UNP Q8U6Q7
A	-9	SER	-	CLONING ARTIFACT	UNP Q8U6Q7
A	-8	GLY	-	CLONING ARTIFACT	UNP Q8U6Q7
A	-7	GLU	-	CLONING ARTIFACT	UNP Q8U6Q7
A	-6	ASN	-	CLONING ARTIFACT	UNP Q8U6Q7
A	-5	LEU	-	CLONING ARTIFACT	UNP Q8U6Q7
A	-4	TYR	-	CLONING ARTIFACT	UNP Q8U6Q7
A	-3	PHE	-	CLONING ARTIFACT	UNP Q8U6Q7
A	-2	GLN	-	CLONING ARTIFACT	UNP Q8U6Q7
A	-1	GLY	-	CLONING ARTIFACT	UNP Q8U6Q7
A	0	HIS	-	CLONING ARTIFACT	UNP Q8U6Q7
A	1	MSE	MET	MODIFIED RESIDUE	UNP Q8U6Q7

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Chain	Residue	Modelled	Actual	Comment	Reference
A	181	MSE	MET	MODIFIED RESIDUE	UNP Q8U6Q7
A	187	MSE	MET	MODIFIED RESIDUE	UNP Q8U6Q7
A	223	MSE	MET	MODIFIED RESIDUE	UNP Q8U6Q7
A	243	MSE	MET	MODIFIED RESIDUE	UNP Q8U6Q7
A	272	MSE	MET	MODIFIED RESIDUE	UNP Q8U6Q7
B	-19	MSE	-	CLONING ARTIFACT	UNP Q8U6Q7
B	-18	GLY	-	CLONING ARTIFACT	UNP Q8U6Q7
B	-17	SER	-	CLONING ARTIFACT	UNP Q8U6Q7
B	-16	SER	-	CLONING ARTIFACT	UNP Q8U6Q7
B	-15	HIS	-	CLONING ARTIFACT	UNP Q8U6Q7
B	-14	HIS	-	CLONING ARTIFACT	UNP Q8U6Q7
B	-13	HIS	-	CLONING ARTIFACT	UNP Q8U6Q7
B	-12	HIS	-	CLONING ARTIFACT	UNP Q8U6Q7
B	-11	HIS	-	CLONING ARTIFACT	UNP Q8U6Q7
B	-10	SER	-	CLONING ARTIFACT	UNP Q8U6Q7
B	-9	SER	-	CLONING ARTIFACT	UNP Q8U6Q7
B	-8	GLY	-	CLONING ARTIFACT	UNP Q8U6Q7
B	-7	GLU	-	CLONING ARTIFACT	UNP Q8U6Q7
B	-6	ASN	-	CLONING ARTIFACT	UNP Q8U6Q7
B	-5	LEU	-	CLONING ARTIFACT	UNP Q8U6Q7
B	-4	TYR	-	CLONING ARTIFACT	UNP Q8U6Q7
B	-3	PHE	-	CLONING ARTIFACT	UNP Q8U6Q7
B	-2	GLN	-	CLONING ARTIFACT	UNP Q8U6Q7
B	-1	GLY	-	CLONING ARTIFACT	UNP Q8U6Q7
B	0	HIS	-	CLONING ARTIFACT	UNP Q8U6Q7
B	1	MSE	MET	MODIFIED RESIDUE	UNP Q8U6Q7
B	181	MSE	MET	MODIFIED RESIDUE	UNP Q8U6Q7
B	187	MSE	MET	MODIFIED RESIDUE	UNP Q8U6Q7
B	223	MSE	MET	MODIFIED RESIDUE	UNP Q8U6Q7
B	243	MSE	MET	MODIFIED RESIDUE	UNP Q8U6Q7
B	272	MSE	MET	MODIFIED RESIDUE	UNP Q8U6Q7
C	-19	MSE	-	CLONING ARTIFACT	UNP Q8U6Q7
C	-18	GLY	-	CLONING ARTIFACT	UNP Q8U6Q7
C	-17	SER	-	CLONING ARTIFACT	UNP Q8U6Q7
C	-16	SER	-	CLONING ARTIFACT	UNP Q8U6Q7
C	-15	HIS	-	CLONING ARTIFACT	UNP Q8U6Q7
C	-14	HIS	-	CLONING ARTIFACT	UNP Q8U6Q7
C	-13	HIS	-	CLONING ARTIFACT	UNP Q8U6Q7
C	-12	HIS	-	CLONING ARTIFACT	UNP Q8U6Q7
C	-11	HIS	-	CLONING ARTIFACT	UNP Q8U6Q7
C	-10	SER	-	CLONING ARTIFACT	UNP Q8U6Q7
C	-9	SER	-	CLONING ARTIFACT	UNP Q8U6Q7

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Chain	Residue	Modelled	Actual	Comment	Reference
C	-8	GLY	-	CLONING ARTIFACT	UNP Q8U6Q7
C	-7	GLU	-	CLONING ARTIFACT	UNP Q8U6Q7
C	-6	ASN	-	CLONING ARTIFACT	UNP Q8U6Q7
C	-5	LEU	-	CLONING ARTIFACT	UNP Q8U6Q7
C	-4	TYR	-	CLONING ARTIFACT	UNP Q8U6Q7
C	-3	PHE	-	CLONING ARTIFACT	UNP Q8U6Q7
C	-2	GLN	-	CLONING ARTIFACT	UNP Q8U6Q7
C	-1	GLY	-	CLONING ARTIFACT	UNP Q8U6Q7
C	0	HIS	-	CLONING ARTIFACT	UNP Q8U6Q7
C	1	MSE	MET	MODIFIED RESIDUE	UNP Q8U6Q7
C	181	MSE	MET	MODIFIED RESIDUE	UNP Q8U6Q7
C	187	MSE	MET	MODIFIED RESIDUE	UNP Q8U6Q7
C	223	MSE	MET	MODIFIED RESIDUE	UNP Q8U6Q7
C	243	MSE	MET	MODIFIED RESIDUE	UNP Q8U6Q7
C	272	MSE	MET	MODIFIED RESIDUE	UNP Q8U6Q7
D	-19	MSE	-	CLONING ARTIFACT	UNP Q8U6Q7
D	-18	GLY	-	CLONING ARTIFACT	UNP Q8U6Q7
D	-17	SER	-	CLONING ARTIFACT	UNP Q8U6Q7
D	-16	SER	-	CLONING ARTIFACT	UNP Q8U6Q7
D	-15	HIS	-	CLONING ARTIFACT	UNP Q8U6Q7
D	-14	HIS	-	CLONING ARTIFACT	UNP Q8U6Q7
D	-13	HIS	-	CLONING ARTIFACT	UNP Q8U6Q7
D	-12	HIS	-	CLONING ARTIFACT	UNP Q8U6Q7
D	-11	HIS	-	CLONING ARTIFACT	UNP Q8U6Q7
D	-10	SER	-	CLONING ARTIFACT	UNP Q8U6Q7
D	-9	SER	-	CLONING ARTIFACT	UNP Q8U6Q7
D	-8	GLY	-	CLONING ARTIFACT	UNP Q8U6Q7
D	-7	GLU	-	CLONING ARTIFACT	UNP Q8U6Q7
D	-6	ASN	-	CLONING ARTIFACT	UNP Q8U6Q7
D	-5	LEU	-	CLONING ARTIFACT	UNP Q8U6Q7
D	-4	TYR	-	CLONING ARTIFACT	UNP Q8U6Q7
D	-3	PHE	-	CLONING ARTIFACT	UNP Q8U6Q7
D	-2	GLN	-	CLONING ARTIFACT	UNP Q8U6Q7
D	-1	GLY	-	CLONING ARTIFACT	UNP Q8U6Q7
D	0	HIS	-	CLONING ARTIFACT	UNP Q8U6Q7
D	1	MSE	MET	MODIFIED RESIDUE	UNP Q8U6Q7
D	181	MSE	MET	MODIFIED RESIDUE	UNP Q8U6Q7
D	187	MSE	MET	MODIFIED RESIDUE	UNP Q8U6Q7
D	223	MSE	MET	MODIFIED RESIDUE	UNP Q8U6Q7
D	243	MSE	MET	MODIFIED RESIDUE	UNP Q8U6Q7
D	272	MSE	MET	MODIFIED RESIDUE	UNP Q8U6Q7

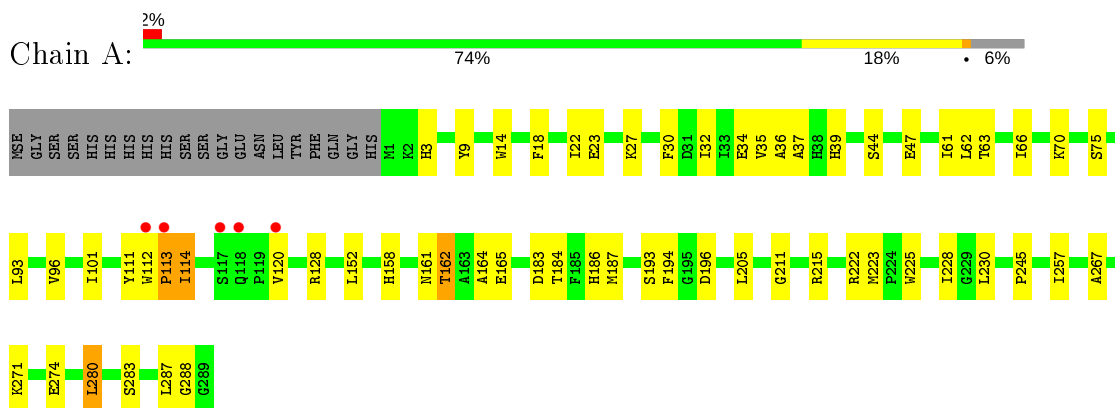
- Molecule 2 is water.

<b>Mol</b>	<b>Chain</b>	<b>Residues</b>	<b>Atoms</b>		<b>ZeroOcc</b>	<b>AltConf</b>
2	A	204	Total 204	O 204	0	0
2	B	182	Total 182	O 182	0	0
2	C	175	Total 175	O 175	0	0
2	D	198	Total 198	O 198	0	0

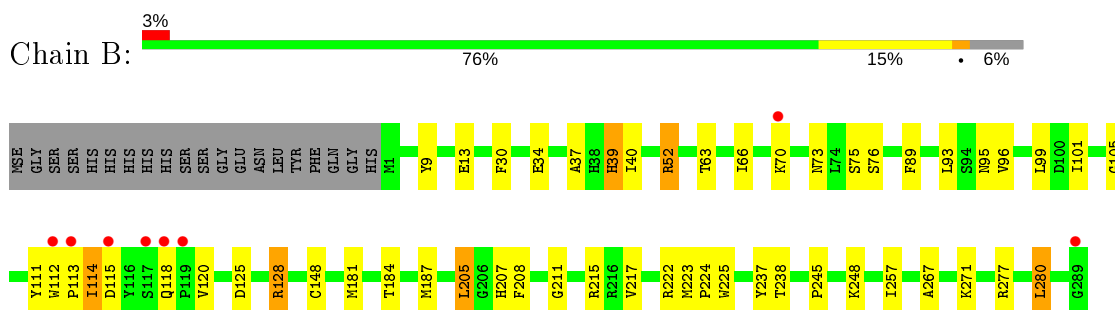
### 3 Residue-property plots [i](#)

These plots are drawn for all protein, RNA and DNA 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.

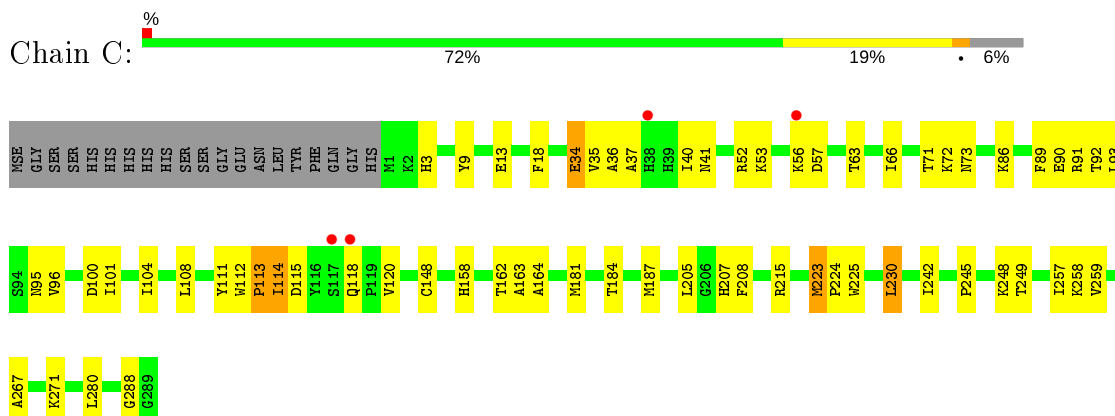
- Molecule 1: D-PSICOSE 3-EPIMERASE




- Molecule 1: D-PSICOSE 3-EPIMERASE

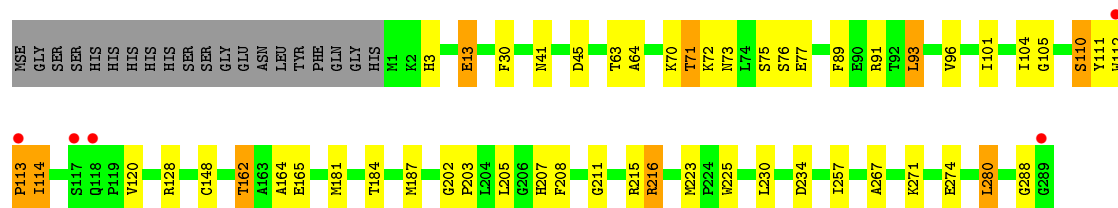


- Molecule 1: D-PSICOSE 3-EPIMERASE



- Molecule 1: D-PSICOSE 3-EPIMERASE

Chain D: 





## 4 Data and refinement statistics

Property	Value	Source
Space group	P 21 21 21	Depositor
Cell constants a, b, c, $\alpha$ , $\beta$ , $\gamma$	102.40Å 113.00Å 131.80Å 90.00° 90.00° 90.00°	Depositor
Resolution (Å)	30.00 – 2.00 29.57 – 2.02	Depositor EDS
% Data completeness (in resolution range)	93.7 (30.00-2.00) 96.1 (29.57-2.02)	Depositor EDS
$R_{merge}$	0.10	Depositor
$R_{sym}$	(Not available)	Depositor
$\langle I/\sigma(I) \rangle$ <sup>1</sup>	2.71 (at 2.01Å)	Xtrriage
Refinement program	CNS	Depositor
R, $R_{free}$	0.197 , 0.233 0.196 , 0.233	Depositor DCC
$R_{free}$ test set	9981 reflections (9.99%)	wwPDB-VP
Wilson B-factor (Å <sup>2</sup> )	23.4	Xtrriage
Anisotropy	0.421	Xtrriage
Bulk solvent $k_{sol}$ (e/Å <sup>3</sup> ), $B_{sol}$ (Å <sup>2</sup> )	0.35 , 55.2	EDS
L-test for twinning <sup>2</sup>	$\langle  L  \rangle = 0.49$ , $\langle L^2 \rangle = 0.33$	Xtrriage
Estimated twinning fraction	No twinning to report.	Xtrriage
$F_o, F_c$ correlation	0.95	EDS
Total number of atoms	9675	wwPDB-VP
Average B, all atoms (Å <sup>2</sup> )	26.0	wwPDB-VP

Xtrriage's analysis on translational NCS is as follows: *The largest off-origin peak in the Patterson function is 3.36% 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

### 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	0.44	0/2274	0.64	0/3065
1	B	0.42	0/2274	0.63	0/3065
1	C	0.43	0/2274	0.66	0/3065
1	D	0.43	0/2274	0.66	0/3065
All	All	0.43	0/9096	0.65	0/12260

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	2229	0	2179	50	0
1	B	2229	0	2179	54	0
1	C	2229	0	2179	54	0
1	D	2229	0	2179	57	0
2	A	204	0	0	7	0
2	B	182	0	0	6	0
2	C	175	0	0	6	0
2	D	198	0	0	5	0
All	All	9675	0	8716	214	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 12.

The worst 5 of 214 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:B:105:GLY:HA3	1:B:181:MSE:HE1	1.21	1.12
1:D:105:GLY:HA3	1:D:181:MSE:HE1	1.15	1.10
1:B:148:CYS:HB2	1:B:181:MSE:HE3	1.40	0.98
1:A:184:THR:HA	1:A:187:MSE:HE3	1.45	0.94
1:D:148:CYS:HB2	1:D:181:MSE:HE3	1.50	0.93

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	287/309 (93%)	279 (97%)	6 (2%)	2 (1%)	22 16
1	B	287/309 (93%)	282 (98%)	4 (1%)	1 (0%)	41 37
1	C	287/309 (93%)	279 (97%)	6 (2%)	2 (1%)	22 16
1	D	287/309 (93%)	278 (97%)	6 (2%)	3 (1%)	15 9
All	All	1148/1236 (93%)	1118 (97%)	22 (2%)	8 (1%)	22 16

5 of 8 Ramachandran outliers are listed below:

Mol	Chain	Res	Type
1	A	113	PRO
1	A	114	ILE
1	C	114	ILE
1	D	113	PRO
1	B	114	ILE

### 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	227/237 (96%)	222 (98%)	5 (2%)	52	55
1	B	227/237 (96%)	220 (97%)	7 (3%)	40	40
1	C	227/237 (96%)	219 (96%)	8 (4%)	36	35
1	D	227/237 (96%)	216 (95%)	11 (5%)	25	22
All	All	908/948 (96%)	877 (97%)	31 (3%)	37	36

5 of 31 residues with a non-rotameric sidechain are listed below:

Mol	Chain	Res	Type
1	C	91	ARG
1	C	230	LEU
1	D	230	LEU
1	C	205	LEU
1	C	258	LYS

Some sidechains can be flipped to improve hydrogen bonding and reduce clashes. 5 of 12 such sidechains are listed below:

Mol	Chain	Res	Type
1	B	134	ASN
1	C	3	HIS
1	D	3	HIS
1	B	95	ASN
1	C	134	ASN

### 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 carbohydrates 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	283/309 (91%)	-0.13	5 (1%) 68 66	13, 22, 43, 53	0
1	B	283/309 (91%)	-0.11	8 (2%) 53 51	16, 24, 37, 54	0
1	C	283/309 (91%)	-0.07	4 (1%) 75 74	15, 26, 40, 54	0
1	D	283/309 (91%)	-0.07	5 (1%) 68 66	14, 24, 42, 52	0
All	All	1132/1236 (91%)	-0.09	22 (1%) 66 65	13, 24, 41, 54	0

The worst 5 of 22 RSRZ outliers are listed below:

Mol	Chain	Res	Type	RSRZ
1	B	289	GLY	4.3
1	A	112	TRP	4.1
1	B	112	TRP	3.7
1	D	117	SER	3.6
1	B	118	GLN	3.3

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

There are no non-standard protein/DNA/RNA residues in this entry.

### 6.3 Carbohydrates [i](#)

There are no carbohydrates in this entry.

### 6.4 Ligands [i](#)

There are no ligands in this entry.

## 6.5 Other polymers

There are no such residues in this entry.