Full wwPDB X-ray Structure Validation Report (i)

Feb 1, 2016 – 07:36 PM GMT

PDB ID	:	4PFH
Title	:	Crystal structure of engineered D-tagatose 3-epimerase PcDTE-IDF8
Authors	:	Hee, C.S.; Bosshart, A.; Schirmer, T.
Deposited on	:	2014-04-29
Resolution	:	1.90 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
http://wwpdb.org/validation/2016/XrayValidationReportHelp
with specific help available everywhere you see the (i) symbol.

The following versions of software and data (see references (1)) were used in the production of this report:

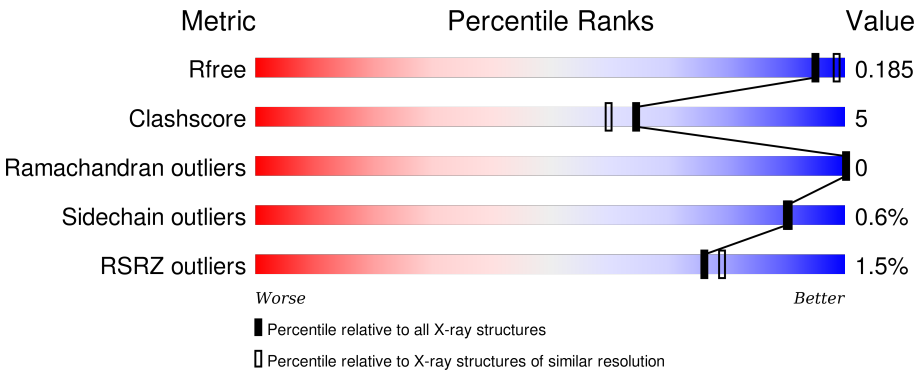
MolProbity	:	4.02b-467
Mogul	:	1.7 (RC4), CSD as536be (2015)
Xtriage (Phenix)	:	1.9-1692
EDS	:	rb-20026688
Percentile statistics	:	20151230.v01 (using entries in the PDB archive December 30th 2015)
Refmac	:	5.8.0135
CCP4	:	6.5.0
Ideal geometry (proteins)	:	Engh & Huber (2001)
Ideal geometry (DNA, RNA)	:	Parkinson et al. (1996)
Validation Pipeline (wwPDB-VP)	:	trunk26865

1 Overall quality at a glance (i)

The following experimental techniques were used to determine the structure:
X-RAY DIFFRACTION

The reported resolution of this entry is 1.90 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}	91344	4755 (1.90-1.90)
Clashscore	102246	5398 (1.90-1.90)
Ramachandran outliers	100387	5338 (1.90-1.90)
Sidechain outliers	100360	5339 (1.90-1.90)
RSRZ outliers	91569	4766 (1.90-1.90)

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 >=3, 2, 1 and 0 types of geometric quality criteria. 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 <=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	298	2% 91% 9%
1	B	298	% 89% 8% •

The following table lists non-polymeric compounds, carbohydrate monomers and non-standard residues in protein, DNA, RNA chains that are outliers for geometric or electron-density-fit criteria:

Mol	Type	Chain	Res	Chirality	Geometry	Clashes	Electron density
3	PSJ	A	503[B]	-	-	-	X
3	PSJ	B	502[B]	-	-	-	X
4	FUD	A	504[A]	-	-	-	X
4	FUD	B	503[A]	-	-	-	X

2 Entry composition (i)

There are 5 unique types of molecules in this entry. The entry contains 5285 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-tagatose 3-epimerase.

Mol	Chain	Residues	Atoms					ZeroOcc	AltConf	Trace
			Total	C	N	O	S			
1	A	298	2447	1548	426	450	23	0	9	0
1	B	291	2367	1501	407	438	21	0	8	0

There are 46 discrepancies between the modelled and reference sequences:

Chain	Residue	Modelled	Actual	Comment	Reference
A	37	ASN	SER	engineered mutation	UNP O50580
A	39	GLU	GLY	engineered mutation	UNP O50580
A	109	ASN	THR	engineered mutation	UNP O50580
A	116	HIS	SER	engineered mutation	UNP O50580
A	122	VAL	LYS	engineered mutation	UNP O50580
A	157	TYR	PHE	engineered mutation	UNP O50580
A	194	ASN	THR	engineered mutation	UNP O50580
A	209	VAL	HIS	engineered mutation	UNP O50580
A	212	ILE	LEU	engineered mutation	UNP O50580
A	215	GLN	ALA	engineered mutation	UNP O50580
A	251	THR	LYS	engineered mutation	UNP O50580
A	256	GLY	SER	engineered mutation	UNP O50580
A	258	ASP	ALA	engineered mutation	UNP O50580
A	260	CYS	GLY	engineered mutation	UNP O50580
A	265	LEU	MET	engineered mutation	UNP O50580
A	291	LEU	-	expression tag	UNP O50580
A	292	GLU	-	expression tag	UNP O50580
A	293	HIS	-	expression tag	UNP O50580
A	294	HIS	-	expression tag	UNP O50580
A	295	HIS	-	expression tag	UNP O50580
A	296	HIS	-	expression tag	UNP O50580
A	297	HIS	-	expression tag	UNP O50580
A	298	HIS	-	expression tag	UNP O50580
B	37	ASN	SER	engineered mutation	UNP O50580
B	39	GLU	GLY	engineered mutation	UNP O50580

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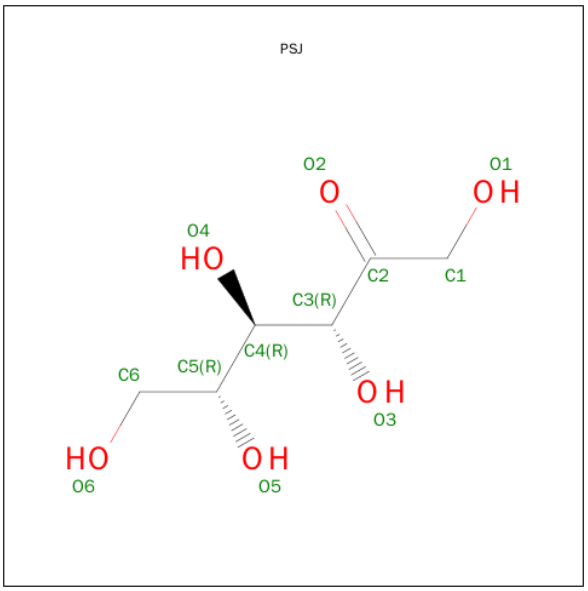
Chain	Residue	Modelled	Actual	Comment	Reference
B	109	ASN	THR	engineered mutation	UNP O50580
B	116	HIS	SER	engineered mutation	UNP O50580
B	122	VAL	LYS	engineered mutation	UNP O50580
B	157	TYR	PHE	engineered mutation	UNP O50580
B	194	ASN	THR	engineered mutation	UNP O50580
B	209	VAL	HIS	engineered mutation	UNP O50580
B	212	ILE	LEU	engineered mutation	UNP O50580
B	215	GLN	ALA	engineered mutation	UNP O50580
B	251	THR	LYS	engineered mutation	UNP O50580
B	256	GLY	SER	engineered mutation	UNP O50580
B	258	ASP	ALA	engineered mutation	UNP O50580
B	260	CYS	GLY	engineered mutation	UNP O50580
B	265	LEU	MET	engineered mutation	UNP O50580
B	291	LEU	-	expression tag	UNP O50580
B	292	GLU	-	expression tag	UNP O50580
B	293	HIS	-	expression tag	UNP O50580
B	294	HIS	-	expression tag	UNP O50580
B	295	HIS	-	expression tag	UNP O50580
B	296	HIS	-	expression tag	UNP O50580
B	297	HIS	-	expression tag	UNP O50580
B	298	HIS	-	expression tag	UNP O50580

- Molecule 2 is MANGANESE (II) ION (three-letter code: MN) (formula: Mn).

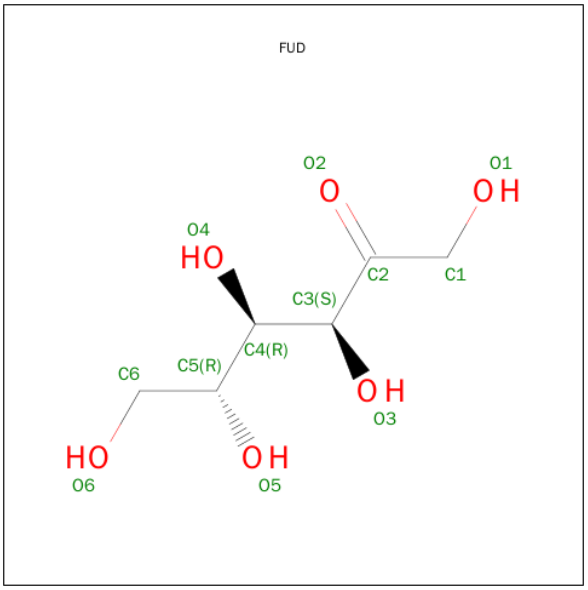
Mol	Chain	Residues	Atoms		ZeroOcc	AltConf
			Total	Mn		
2	B	1	1	1	0	0
			Total	Mn		
2	A	2	2	2	0	0

- Molecule 3 is SUGAR (D-psicose) (three-letter code: PSJ) (formula: $C_6H_{12}O_6$).



Mol	Chain	Residues	Atoms			ZeroOcc	AltConf
			Total	C	O		
3	A	1	12	6	6	0	1
			Total	C	O		
3	B	1	12	6	6	0	1

- Molecule 4 is SUGAR (D-fructose) (three-letter code: FUD) (formula: $C_6H_{12}O_6$).



Mol	Chain	Residues	Atoms			ZeroOcc	AltConf
			Total	C	O		
4	A	1	12	6	6	0	1
			Total	C	O		
4	B	1	12	6	6	0	1

- Molecule 5 is water.

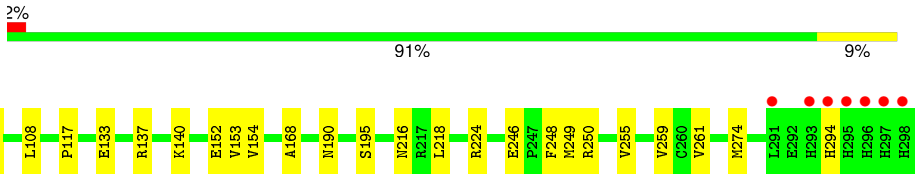
Mol	Chain	Residues	Atoms		ZeroOcc	AltConf
			Total	O		
5	A	236	241	241	0	5
			Total	O		
5	B	175	179	179	0	4

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 errors 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.

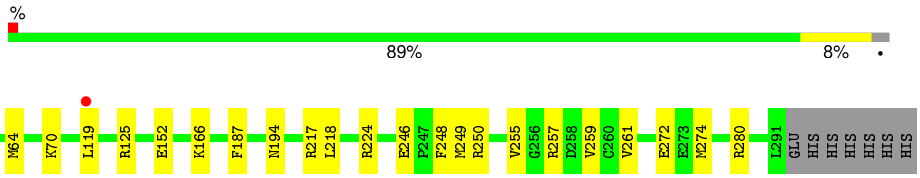
- Molecule 1: D-tagatose 3-epimerase

Chain A:



- Molecule 1: D-tagatose 3-epimerase

Chain B:



4 Data and refinement statistics (i)

Property	Value	Source
Space group	P 1 21 1	Depositor
Cell constants a, b, c, α, β, γ	57.46Å 86.74Å 61.82Å 90.00° 99.10° 90.00°	Depositor
Resolution (Å)	56.74 – 1.90 56.74 – 1.90	Depositor EDS
% Data completeness (in resolution range)	98.6 (56.74-1.90) 98.6 (56.74-1.90)	Depositor EDS
R_{merge}	0.12	Depositor
R_{sym}	(Not available)	Depositor
$< I/\sigma(I) >$ [1]	4.11 (at 1.90Å)	Xtriage
Refinement program	REFMAC 5.7.0029	Depositor
R, R_{free}	0.144 , 0.177 0.156 , 0.185	Depositor DCC
R_{free} test set	2357 reflections (5.33%)	DCC
Wilson B-factor (Å^2)	14.1	Xtriage
Anisotropy	0.417	Xtriage
Bulk solvent k_{sol}(e/Å^3), B_{sol}(Å^2)	0.40 , 52.2	EDS
Estimated twinning fraction	No twinning to report.	Xtriage
L-test for twinning[2]	$< \|L\| > = 0.49$, $< L^2 > = 0.32$	Xtriage
Outliers	0 of 46571 reflections	Xtriage
F_o,F_c correlation	0.96	EDS
Total number of atoms	5285	wwPDB-VP
Average B, all atoms (Å^2)	17.0	wwPDB-VP

Xtriage's analysis on translational NCS is as follows: *The largest off-origin peak in the Patterson function is 6.58% of the height of the origin peak. No significant pseudotranslation is detected.*

[1] Intensities estimated from amplitudes.

[2] Theoretical values of $< |L| >$, $< L^2 >$ for acentric reflections are 0.5, 0.375 respectively for untwinned datasets, and 0.333, 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: PSJ, FUD, MN

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	0.70	0/2513	0.77	1/3393 (0.0%)
1	B	0.64	0/2430	0.75	0/3281
All	All	0.67	0/4943	0.76	1/6674 (0.0%)

There are no bond length outliers.

All (1) bond angle outliers are listed below:

Mol	Chain	Res	Type	Atoms	Z	Observed(^{o})	Ideal(^{o})
1	A	83	ARG	NE-CZ-NH2	5.15	122.87	120.30

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	2447	0	2379	24	0
1	B	2367	0	2328	24	0
2	A	2	0	0	0	0
2	B	1	0	0	0	0
3	A	12	0	11	2	0
3	B	12	0	11	3	0
4	A	12	0	11	1	0
4	B	12	0	12	1	0

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Mol	Chain	Non-H	H(model)	H(added)	Clashes	Symm-Clashes
5	A	241	0	0	4	0
5	B	179	0	0	6	0
All	All	5285	0	4752	49	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 5.

All (49) 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:280:ARG:HD2	5:B:604:HOH:O	1.40	1.19
1:B:152:GLU:OE1	3:B:502[B]:PSJ:H3	1.57	1.02
3:B:502[B]:PSJ:H1	3:B:502[B]:PSJ:O4	1.68	0.90
1:A:33:LEU:HD11	1:A:64[B]:MET:HE3	1.53	0.90
1:A:137:ARG:HG2	1:A:137:ARG:HH21	1.57	0.69
1:B:166:LYS:HE3	5:B:736:HOH:O	1.97	0.64
1:A:216:ASN:ND2	1:B:194[A]:ASN:OD1	2.32	0.63
1:A:152:GLU:OE1	3:A:503[B]:PSJ:H3	2.00	0.62
1:B:272:GLU:HG2	5:B:717:HOH:O	1.99	0.62
1:B:249[A]:MET:CE	1:B:274[A]:MET:SD	2.89	0.60
3:B:502[B]:PSJ:C1	3:B:502[B]:PSJ:O4	2.44	0.60
1:A:133[B]:GLU:HG2	5:A:666:HOH:O	2.00	0.59
1:A:33:LEU:HD11	1:A:64[B]:MET:CE	2.31	0.59
1:A:259[B]:VAL:HG23	1:A:261:VAL:HG23	1.85	0.57
1:B:259:VAL:HG23	1:B:261:VAL:HG23	1.87	0.56
1:B:224[B]:ARG:NH2	5:B:731:HOH:O	2.41	0.53
1:B:70[B]:LYS:HE3	5:B:727:HOH:O	2.08	0.53
1:A:250:ARG:CZ	1:A:274[B]:MET:SD	2.98	0.51
1:B:218:LEU:HD23	1:B:249[A]:MET:HG2	1.93	0.49
1:B:246:GLU:OE2	4:B:503[A]:FUD:C3	2.61	0.49
1:B:255:VAL:O	1:B:259:VAL:HG22	2.14	0.47
1:A:246:GLU:HG2	1:A:248:PHE:CE2	2.50	0.47
1:B:125:ARG:O	1:B:125:ARG:HD3	2.14	0.46
3:A:503[B]:PSJ:H1A	3:A:503[B]:PSJ:O4	2.14	0.46
1:A:153:VAL:HG22	1:A:168:ALA:HB2	1.97	0.46
1:B:119:LEU:HD12	1:B:119:LEU:C	2.36	0.46
1:A:140:LYS:HE2	5:A:814:HOH:O	2.15	0.46
1:A:190:ASN:OD1	1:B:224[B]:ARG:NH1	2.47	0.46
1:A:108:LEU:HD21	1:A:154:VAL:HG11	1.98	0.46
1:A:117:PRO:O	1:B:257[B]:ARG:NH2	2.49	0.45
1:A:64[B]:MET:HB3	1:A:64[B]:MET:HE3	1.73	0.45

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Atom-1	Atom-2	Interatomic distance (Å)	Clash overlap (Å)
1:B:70[B]:LYS:HD2	1:B:70[B]:LYS:HA	1.74	0.45
1:A:249[A]:MET:CE	1:A:274[A]:MET:SD	3.05	0.45
1:B:8:TYR:CE1	1:B:9:THR:HG23	2.52	0.44
1:A:137:ARG:NH2	1:A:137:ARG:HG2	2.29	0.44
1:B:246:GLU:HG2	1:B:248:PHE:CE2	2.52	0.44
1:A:255:VAL:O	1:A:259[B]:VAL:HG22	2.18	0.44
4:A:504[A]:FUD:H12	4:A:504[A]:FUD:H4	1.59	0.43
1:B:250:ARG:CZ	1:B:274[B]:MET:SD	3.06	0.43
1:A:33:LEU:HD21	1:A:64[A]:MET:HG2	2.00	0.42
1:A:140:LYS:HG2	5:A:711:HOH:O	2.18	0.42
1:A:249[A]:MET:HE2	1:A:274[A]:MET:SD	2.59	0.42
1:B:249[A]:MET:HE2	1:B:274[A]:MET:SD	2.59	0.42
1:A:140:LYS:CE	5:A:814:HOH:O	2.68	0.41
1:B:272:GLU:HA	1:B:272:GLU:OE1	2.21	0.41
1:B:33:LEU:HD21	1:B:64:MET:HG2	2.02	0.40
1:A:224[B]:ARG:NH2	5:B:733[B]:HOH:O	2.50	0.40
1:A:218:LEU:HD23	1:A:249[A]:MET:HG2	2.03	0.40
1:B:187:PHE:CD1	1:B:217:ARG:HG2	2.57	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	305/298 (102%)	299 (98%)	6 (2%)	0	100	100
1	B	297/298 (100%)	294 (99%)	3 (1%)	0	100	100
All	All	602/596 (101%)	593 (98%)	9 (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	260/251 (104%)	258 (99%)	2 (1%)	86	86
1	B	252/251 (100%)	251 (100%)	1 (0%)	93	94
All	All	512/502 (102%)	509 (99%)	3 (1%)	90	90

All (3) residues with a non-rotameric sidechain are listed below:

Mol	Chain	Res	Type
1	A	195	SER
1	A	294	HIS
1	B	8	TYR

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

Mol	Chain	Res	Type
1	A	2	ASN
1	A	194	ASN
1	A	267	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)

Of 7 ligands modelled in this entry, 3 are monoatomic - leaving 4 for Mogul analysis.

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	$\#\|Z\| > 2$
3	PSJ	A	503[B]	2	11,11,11	0.70	0	10,14,14	1.07	0
4	FUD	A	504[A]	2	11,11,11	1.04	1 (9%)	10,14,14	1.57	1 (10%)
3	PSJ	B	502[B]	2	11,11,11	0.56	0	10,14,14	0.75	0
4	FUD	B	503[A]	2	11,11,11	0.83	0	10,14,14	1.07	0

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. '-' means no outliers of that kind were identified.

Mol	Type	Chain	Res	Link	Chirals	Torsions	Rings
3	PSJ	A	503[B]	2	-	0/16/16/16	0/0/0/0
4	FUD	A	504[A]	2	-	0/16/16/16	0/0/0/0
3	PSJ	B	502[B]	2	-	0/16/16/16	0/0/0/0
4	FUD	B	503[A]	2	-	0/16/16/16	0/0/0/0

All (1) bond length outliers are listed below:

Mol	Chain	Res	Type	Atoms	Z	Observed(Å)	Ideal(Å)
4	A	504[A]	FUD	O3-C3	2.18	1.46	1.42

All (1) bond angle outliers are listed below:

Mol	Chain	Res	Type	Atoms	Z	Observed(^{o})	Ideal(^{o})
4	A	504[A]	FUD	O3-C3-C4	2.90	116.47	110.41

There are no chirality outliers.

There are no torsion outliers.

There are no ring outliers.

4 monomers are involved in 7 short contacts:

Mol	Chain	Res	Type	Clashes	Symm-Clashes
3	A	503[B]	PSJ	2	0
4	A	504[A]	FUD	1	0
3	B	502[B]	PSJ	3	0
4	B	503[A]	FUD	1	0

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, 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	298/298 (100%)	-0.38	7 (2%)	64	67	5, 12, 31, 71	0
1	B	291/298 (97%)	-0.37	2 (0%)	89	90	5, 17, 35, 53	0
All	All	589/596 (98%)	-0.38	9 (1%)	76	79	5, 14, 34, 71	0

All (9) RSRZ outliers are listed below:

Mol	Chain	Res	Type	RSRZ
1	A	291	LEU	3.3
1	B	119	LEU	3.2
1	A	298	HIS	3.0
1	A	295	HIS	3.0
1	B	1	MET	2.8
1	A	294	HIS	2.6
1	A	293	HIS	2.5
1	A	297	HIS	2.4
1	A	296	HIS	2.1

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)

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. LLDF column lists the quality of electron

density of the group with respect to its neighbouring residues in protein, DNA or RNA chains. 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	LLDF	B-factors(Å^2)	Q<0.9
4	FUD	B	503[A]	12/12	0.90	0.20	11.00	25,35,44,46	12
3	PSJ	B	502[B]	12/12	0.95	0.20	8.37	8,10,12,13	12
3	PSJ	A	503[B]	12/12	0.88	0.18	8.08	19,22,24,24	12
4	FUD	A	504[A]	12/12	0.93	0.14	4.70	18,34,51,54	12
2	MN	A	502	1/1	1.00	0.04	-1.25	15,15,15,15	0
2	MN	B	501	1/1	0.99	0.04	-3.52	16,16,16,16	0
2	MN	A	501	1/1	0.99	0.04	-4.95	14,14,14,14	0

6.5 Other polymers (i)

There are no such residues in this entry.