Full wwPDB X-ray Structure Validation Report ⓘ

Mar 20, 2025 – 06:03 PM EDT

PDB ID	:	4F5J
Title	:	Rational Design and Directed Evolution for Conversion of Substrate Specificity from E.coli Aspartate Aminotransferase to Tyrosine Aminotransferase: Mutant P5.
Authors	:	Addington, T.A.; Fisher, A.J.; Toney, M.D.
Deposited on	:	2012-05-13
Resolution	:	1.95 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
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:

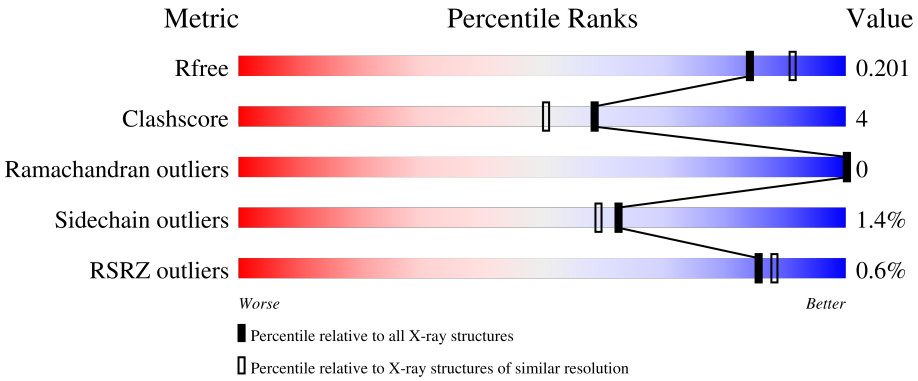
MolProbity	:	4.02b-467
Mogul	:	2022.3.0, CSD as543be (2022)
Xtriage (Phenix)	:	1.21
EDS	:	3.0
Percentile statistics	:	20231227.v01 (using entries in the PDB archive December 27th 2023)
CCP4	:	9.0.004 (Gargrove)
Density-Fitness	:	1.0.11
Ideal geometry (proteins)	:	Engh & Huber (2001)
Ideal geometry (DNA, RNA)	:	Parkinson et al. (1996)
Validation Pipeline (wwPDB-VP)	:	2.41.4

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 1.95 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}	164625	3187 (1.96-1.96)
Clashscore	180529	3412 (1.96-1.96)
Ramachandran outliers	177936	3390 (1.96-1.96)
Sidechain outliers	177891	3390 (1.96-1.96)
RSRZ outliers	164620	3186 (1.96-1.96)

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 <=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	406	% 90% 8% .
1	B	406	88% 9% ..

2 Entry composition (i)

There are 2 unique types of molecules in this entry. The entry contains 7217 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 Aspartate aminotransferase.

Mol	Chain	Residues	Atoms						ZeroOcc	AltConf	Trace
1	A	399	Total	C	N	O	P	S	0	6	0
			3131	1966	547	604	1	13			
1	B	399	Total	C	N	O	P	S	0	7	0
			3144	1972	556	602	1	13			

There are 50 discrepancies between the modelled and reference sequences:

Chain	Residue	Modelled	Actual	Comment	Reference
A	1	MET	-	expression tag	UNP P00509
A	2	ALA	-	expression tag	UNP P00509
A	3	HIS	-	expression tag	UNP P00509
A	4	HIS	-	expression tag	UNP P00509
A	5	HIS	-	expression tag	UNP P00509
A	6	HIS	-	expression tag	UNP P00509
A	7	HIS	-	expression tag	UNP P00509
A	8	HIS	-	expression tag	UNP P00509
A	9	VAL	-	expression tag	UNP P00509
A	10	GLY	-	expression tag	UNP P00509
A	11	THR	-	expression tag	UNP P00509
A	39	VAL	ILE	engineered mutation	UNP P00509
A	40	ASP	ASN	engineered mutation	UNP P00509
A	43	VAL	ILE	engineered mutation	UNP P00509
A	74	THR	ASN	engineered mutation	UNP P00509
A	78	LEU	ILE	engineered mutation	UNP P00509
A	81	LEU	ILE	engineered mutation	UNP P00509
A	114	SER	THR	engineered mutation	UNP P00509
A	145	ALA	SER	engineered mutation	UNP P00509
A	146	ILE	VAL	engineered mutation	UNP P00509
A	197	ALA	ILE	engineered mutation	UNP P00509
A	220	ILE	PHE	engineered mutation	UNP P00509
A	222	ILE	PHE	engineered mutation	UNP P00509
A	228	GLY	ALA	engineered mutation	UNP P00509
A	254	CYS	TYR	engineered mutation	UNP P00509

Continued on next page...

Continued from previous page...

Chain	Residue	Modelled	Actual	Comment	Reference
B	1	MET	-	expression tag	UNP P00509
B	2	ALA	-	expression tag	UNP P00509
B	3	HIS	-	expression tag	UNP P00509
B	4	HIS	-	expression tag	UNP P00509
B	5	HIS	-	expression tag	UNP P00509
B	6	HIS	-	expression tag	UNP P00509
B	7	HIS	-	expression tag	UNP P00509
B	8	HIS	-	expression tag	UNP P00509
B	9	VAL	-	expression tag	UNP P00509
B	10	GLY	-	expression tag	UNP P00509
B	11	THR	-	expression tag	UNP P00509
B	39	VAL	ILE	engineered mutation	UNP P00509
B	40	ASP	ASN	engineered mutation	UNP P00509
B	43	VAL	ILE	engineered mutation	UNP P00509
B	74	THR	ASN	engineered mutation	UNP P00509
B	78	LEU	ILE	engineered mutation	UNP P00509
B	81	LEU	ILE	engineered mutation	UNP P00509
B	114	SER	THR	engineered mutation	UNP P00509
B	145	ALA	SER	engineered mutation	UNP P00509
B	146	ILE	VAL	engineered mutation	UNP P00509
B	197	ALA	ILE	engineered mutation	UNP P00509
B	220	ILE	PHE	engineered mutation	UNP P00509
B	222	ILE	PHE	engineered mutation	UNP P00509
B	228	GLY	ALA	engineered mutation	UNP P00509
B	254	CYS	TYR	engineered mutation	UNP P00509

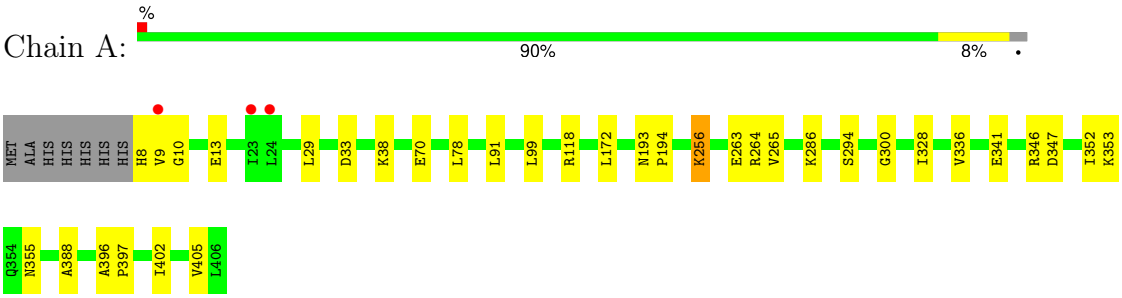
- Molecule 2 is water.

Mol	Chain	Residues	Atoms	ZeroOcc	AltConf
2	A	446	Total O 446 446	0	0
2	B	496	Total O 496 496	0	0

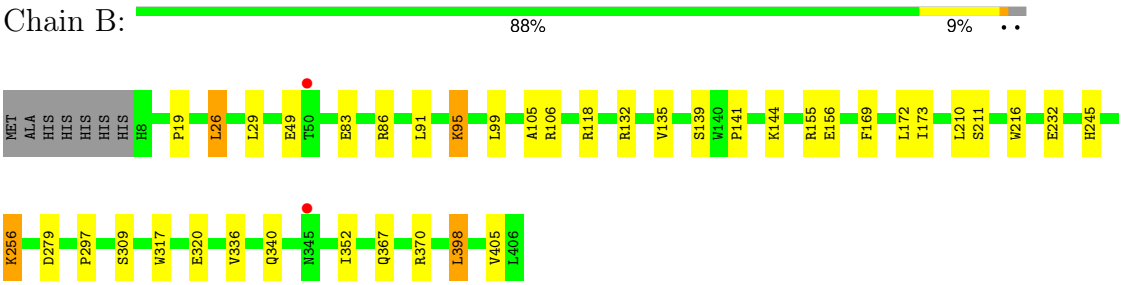
3 Residue-property plots (i)

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: Aspartate aminotransferase



• Molecule 1: Aspartate aminotransferase



4 Data and refinement statistics (i)

Property	Value	Source
Space group	P 21 21 21	Depositor
Cell constants a, b, c, α, β, γ	59.71Å 102.98Å 139.34Å 90.00° 90.00° 90.00°	Depositor
Resolution (Å)	51.65 – 1.95 51.65 – 1.95	Depositor EDS
% Data completeness (in resolution range)	99.9 (51.65-1.95) 99.9 (51.65-1.95)	Depositor EDS
R_{merge}	0.08	Depositor
R_{sym}	0.08	Depositor
$< I/\sigma(I) >$ [1]	2.22 (at 1.95Å)	Xtriage
Refinement program	PHENIX (phenix.refine: 1.7.1_743)	Depositor
R, R_{free}	0.161 , 0.204 0.158 , 0.201	Depositor DCC
R_{free} test set	3112 reflections (4.94%)	wwPDB-VP
Wilson B-factor (Å^2)	17.4	Xtriage
Anisotropy	0.412	Xtriage
Bulk solvent k_{sol}(e/Å^3), B_{sol}(Å^2)	0.35 , 59.0	EDS
L-test for twinning[2]	$< \|L\| > = 0.49$, $< L^2 > = 0.33$	Xtriage
Estimated twinning fraction	No twinning to report.	Xtriage
F_o,F_c correlation	0.96	EDS
Total number of atoms	7217	wwPDB-VP
Average B, all atoms (Å^2)	20.0	wwPDB-VP

Xtriage's analysis on translational NCS is as follows: *The largest off-origin peak in the Patterson function is 5.66% 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, 0.333 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: LLP

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	0.35	0/3165	0.52	0/4289
1	B	0.36	0/3178	0.53	1/4304 (0.0%)
All	All	0.36	0/6343	0.52	1/8593 (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	B	398	LEU	CA-CB-CG	5.78	128.59	115.30

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	3131	0	3062	26	0
1	B	3144	0	3085	29	0
2	A	446	0	0	5	0
2	B	496	0	0	10	0
All	All	7217	0	6147	53	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 4.

All (53) 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:A:8:HIS:N	2:A:892:HOH:O	2.06	0.89
1:B:83:GLU:OE1	1:B:86[A]:ARG:NH2	2.06	0.86
1:B:19:PRO:O	2:B:941:HOH:O	1.99	0.79
1:B:232:GLU:OE2	2:B:888:HOH:O	2.00	0.79
1:B:340:GLN:NE2	2:B:911:HOH:O	2.18	0.74
1:B:139:SER:HB2	2:B:829:HOH:O	1.95	0.67
1:B:141:PRO:O	2:B:883:HOH:O	2.13	0.66
1:B:370:ARG:HD3	1:B:405:VAL:HG22	1.78	0.65
1:A:353:LYS:HB2	2:A:874:HOH:O	1.98	0.63
1:B:169:PHE:CZ	1:B:173[B]:ILE:HD11	2.35	0.62
1:A:396:ALA:HB3	1:A:397:PRO:HD3	1.79	0.62
1:A:341:GLU:HG3	2:A:927:HOH:O	2.00	0.61
1:A:118:ARG:HH21	1:B:118:ARG:HH21	1.48	0.60
1:B:132[A]:ARG:HD2	1:B:155:ARG:HG3	1.83	0.60
1:A:13:GLU:HG2	2:B:807:HOH:O	2.03	0.57
1:A:256:LLP:H4'1	1:A:256:LLP:OP4	2.06	0.56
1:A:265[A]:VAL:CG2	1:A:300:GLY:HA3	2.35	0.56
1:A:78:LEU:HD23	1:A:294:SER:O	2.07	0.55
1:B:49:GLU:H	1:B:49:GLU:CD	2.09	0.55
1:B:211:SER:OG	1:B:245:HIS:CE1	2.60	0.55
1:B:211:SER:HB3	1:B:245:HIS:NE2	2.21	0.54
1:B:309[B]:SER:OG	2:B:990:HOH:O	2.18	0.52
1:A:346:ARG:HG2	1:A:347:ASP:N	2.25	0.52
1:B:245:HIS:CE1	2:B:809:HOH:O	2.62	0.52
1:A:256:LLP:O3	1:A:256:LLP:NZ	2.43	0.51
1:A:341:GLU:OE1	2:A:927:HOH:O	2.18	0.51
1:A:99:LEU:HD23	1:A:99:LEU:C	2.31	0.51
1:A:78:LEU:HD13	1:A:286:LYS:HB3	1.95	0.48
1:A:328[A]:ILE:HD11	1:A:388:ALA:HB2	1.95	0.47
1:B:210:LEU:HG	1:B:216:TRP:CH2	2.52	0.45
1:B:211:SER:OG	1:B:245:HIS:HE1	1.99	0.45
1:A:336:VAL:HG21	1:A:352:ILE:HG13	1.97	0.45
1:B:336:VAL:HG21	1:B:352:ILE:HG13	1.98	0.44
1:B:99:LEU:CD2	1:B:105:ALA:HB2	2.48	0.44
1:B:106[A]:ARG:NE	1:B:279:ASP:OD1	2.50	0.44
1:A:70:GLU:HG3	2:A:759:HOH:O	2.17	0.43
1:A:264:ARG:HG2	1:B:297:PRO:HA	1.99	0.43
1:B:144:LYS:HD2	2:B:773:HOH:O	2.18	0.43
1:B:256:LLP:O3	1:B:256:LLP:NZ	2.51	0.43
1:A:172:LEU:HD23	1:A:172:LEU:C	2.39	0.42

Continued on next page...

Continued from previous page...

Atom-1	Atom-2	Interatomic distance (Å)	Clash overlap (Å)
1:A:265[A]:VAL:HG22	1:A:300:GLY:HA3	2.01	0.42
1:A:33:ASP:HB3	1:A:38:LYS:HD3	2.01	0.42
1:B:367:GLN:HG2	1:B:405:VAL:HG13	2.01	0.42
1:A:193:ASN:HA	1:A:194:PRO:HA	1.83	0.42
1:A:402:ILE:O	1:A:405:VAL:HG22	2.20	0.42
1:B:86[A]:ARG:HG3	2:B:718:HOH:O	2.20	0.42
1:A:9:VAL:HG22	1:A:10:GLY:N	2.35	0.41
1:A:263:GLU:OE1	1:A:263:GLU:HA	2.20	0.41
1:B:317:TRP:HA	1:B:320:GLU:OE1	2.20	0.41
1:B:135:VAL:O	1:B:156:GLU:HA	2.21	0.41
1:B:95:LYS:HE3	1:B:95:LYS:HB2	1.91	0.41
1:B:26:LEU:HD12	1:B:26:LEU:HA	1.91	0.40
1:A:256:LLP:OP4	1:A:256:LLP:C4'	2.69	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	402/406 (99%)	393 (98%)	9 (2%)	0	100	100
1	B	403/406 (99%)	392 (97%)	11 (3%)	0	100	100
All	All	805/812 (99%)	785 (98%)	20 (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	325/325 (100%)	321 (99%)	4 (1%)	67	65
1	B	326/325 (100%)	320 (98%)	6 (2%)	54	49
All	All	651/650 (100%)	641 (98%)	10 (2%)	62	57

All (10) residues with a non-rotameric sidechain are listed below:

Mol	Chain	Res	Type
1	A	29	LEU
1	A	91	LEU
1	A	355[A]	ASN
1	A	355[B]	ASN
1	B	26	LEU
1	B	29	LEU
1	B	91	LEU
1	B	95	LYS
1	B	172	LEU
1	B	398	LEU

Sometimes sidechains can be flipped to improve hydrogen bonding and reduce clashes. There are no such sidechains identified.

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	$\#\|Z\|>2$
1	LLP	B	256	1	23,24,25	1.73	4 (17%)	25,32,34	1.65	4 (16%)
1	LLP	A	256	1	23,24,25	1.66	4 (17%)	25,32,34	1.54	5 (20%)

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
1	LLP	B	256	1	-	4/16/17/19	0/1/1/1
1	LLP	A	256	1	-	6/16/17/19	0/1/1/1

All (8) bond length outliers are listed below:

Mol	Chain	Res	Type	Atoms	Z	Observed(Å)	Ideal(Å)
1	B	256	LLP	O3-C3	-5.74	1.23	1.36
1	A	256	LLP	O3-C3	-5.59	1.24	1.36
1	A	256	LLP	C4-C4'	2.48	1.51	1.46
1	B	256	LLP	CE-NZ	2.44	1.52	1.46
1	B	256	LLP	C2-N1	2.41	1.38	1.33
1	B	256	LLP	C4-C4'	2.27	1.51	1.46
1	A	256	LLP	CE-NZ	2.20	1.51	1.46
1	A	256	LLP	C4'-NZ	2.04	1.34	1.27

All (9) bond angle outliers are listed below:

Mol	Chain	Res	Type	Atoms	Z	Observed(^{o})	Ideal(^{o})
1	B	256	LLP	OP4-C5'-C5	5.42	119.52	109.36
1	A	256	LLP	OP4-C5'-C5	4.61	118.00	109.36
1	B	256	LLP	OP3-P-OP4	-2.84	99.26	106.67
1	B	256	LLP	C4-C4'-NZ	-2.84	110.95	124.04
1	A	256	LLP	C5'-C5-C6	-2.55	115.21	119.36
1	A	256	LLP	C4-C4'-NZ	-2.46	112.69	124.04
1	A	256	LLP	OP2-P-OP4	-2.40	100.40	106.67
1	A	256	LLP	OP3-P-OP2	2.28	116.33	107.80
1	B	256	LLP	OP3-P-OP2	2.00	115.31	107.80

There are no chirality outliers.

All (10) torsion outliers are listed below:

Mol	Chain	Res	Type	Atoms
1	A	256	LLP	C4-C5-C5'-OP4
1	A	256	LLP	C6-C5-C5'-OP4
1	A	256	LLP	C5'-OP4-P-OP2
1	B	256	LLP	C4-C5-C5'-OP4
1	B	256	LLP	C6-C5-C5'-OP4
1	B	256	LLP	CA-CB-CG-CD
1	A	256	LLP	CA-CB-CG-CD
1	A	256	LLP	C5'-OP4-P-OP1
1	A	256	LLP	C5'-OP4-P-OP3
1	B	256	LLP	C5'-OP4-P-OP3

There are no ring outliers.

2 monomers are involved in 4 short contacts:

Mol	Chain	Res	Type	Clashes	Symm-Clashes
1	B	256	LLP	1	0
1	A	256	LLP	3	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

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, 95^{th} 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	398/406 (98%)	-0.49	3 (0%)	82	85	4, 16, 38, 57	6 (1%)
1	B	398/406 (98%)	-0.61	2 (0%)	87	89	5, 15, 32, 56	7 (1%)
All	All	796/812 (98%)	-0.55	5 (0%)	85	88	4, 16, 36, 57	13 (1%)

All (5) RSRZ outliers are listed below:

Mol	Chain	Res	Type	RSRZ
1	B	50[A]	THR	5.1
1	A	24	LEU	2.4
1	A	23	ILE	2.2
1	B	345	ASN	2.2
1	A	9	VAL	2.1

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

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^{th} 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^2)	Q<0.9
1	LLP	A	256	24/25	0.97	0.05	6,11,17,20	0
1	LLP	B	256	24/25	0.99	0.04	6,10,13,15	0

6.3 Carbohydrates

There are no monosaccharides in this entry.

6.4 Ligands

There are no ligands in this entry.

6.5 Other polymers

There are no such residues in this entry.