



# wwPDB X-ray Structure Validation Summary Report ⓘ

Mar 6, 2026 – 02:19 AM UTC

PDB ID : 2E9F / pdb\_00002e9f  
Title : Crystal Structure of T.th.HB8 Argininosuccinate lyase complexed with L-Arginine  
Authors : Goto, M.  
Deposited on : 2007-01-25  
Resolution : 2.80 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.

The types of validation reports are described at

<http://www.wwpdb.org/validation/2017/FAQs#types>.

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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

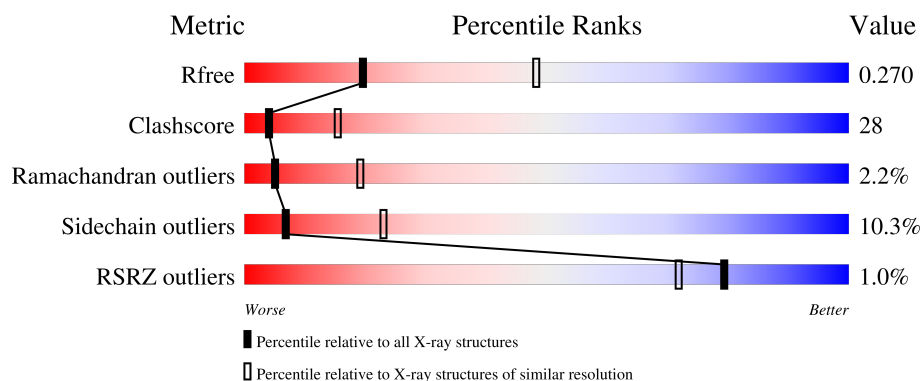
# 1 Overall quality at a glance

The following experimental techniques were used to determine the structure:

*X-RAY DIFFRACTION*

The reported resolution of this entry is 2.80 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	3866 (2.80-2.80)
Clashscore	190562	4276 (2.80-2.80)
Ramachandran outliers	187476	4196 (2.80-2.80)
Sidechain outliers	187428	4198 (2.80-2.80)
RSRZ outliers	180081	3869 (2.80-2.80)

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  $\geq 3$ , 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	462	<div> <div>51%</div> <div>38%</div> <div>6%</div> <div>••</div> </div>
1	B	462	<div> <div>51%</div> <div>38%</div> <div>8%</div> <div>••</div> </div>
1	C	462	<div> <div>49%</div> <div>39%</div> <div>9%</div> <div>•</div> </div>
1	D	462	<div> <div>48%</div> <div>40%</div> <div>8%</div> <div>•</div> </div>

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
2	ARG	B	491	-	-	X	-
2	ARG	B	492	-	-	X	-

## 2 Entry composition [i](#)

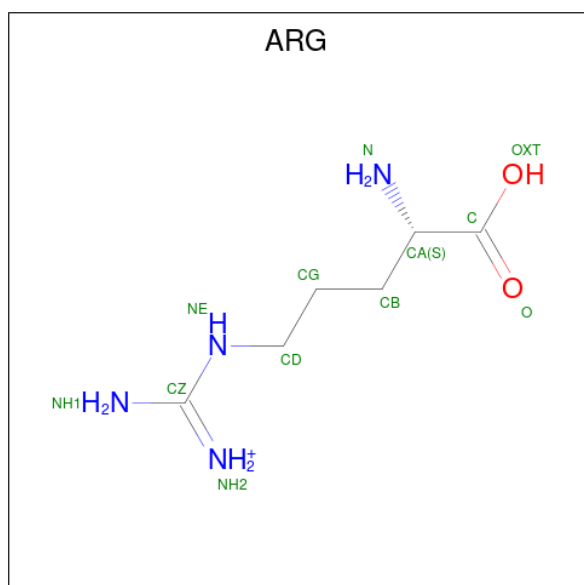
There are 3 unique types of molecules in this entry. The entry contains 14218 atoms, of which 0 are hydrogens and 0 are deuteriums.

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 Argininosuccinate lyase.

Mol	Chain	Residues	Atoms					ZeroOcc	AltConf	Trace
1	A	449	Total	C	N	O	S	0	0	0
			3530	2243	636	644	7			
1	B	450	Total	C	N	O	S	0	0	0
			3528	2241	637	643	7			
1	C	448	Total	C	N	O	S	0	0	0
			3498	2227	626	638	7			
1	D	449	Total	C	N	O	S	0	0	0
			3479	2216	625	631	7			

- Molecule 2 is ARGinine (CCD ID: ARG) (formula: C<sub>6</sub>H<sub>15</sub>N<sub>4</sub>O<sub>2</sub>).



Mol	Chain	Residues	Atoms				ZeroOcc	AltConf
2	B	1	Total	C	N	O	0	0
			12	6	4	2		
2	B	1	Total	C	N	O	0	0
			12	6	4	2		

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Mol	Chain	Residues	Atoms				ZeroOcc	AltConf
2	B	1	Total	C	N	O	0	0
			12	6	4	2		
2	B	1	Total	C	N	O	0	0
			12	6	4	2		

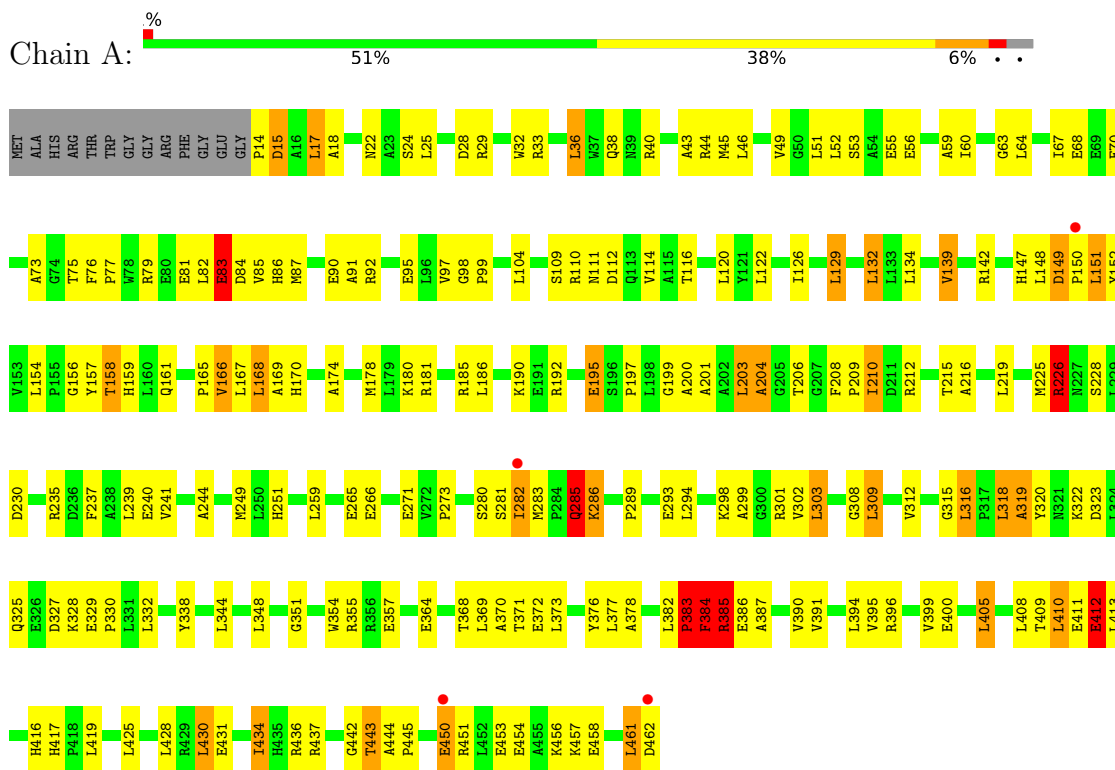
- Molecule 3 is water.

Mol	Chain	Residues	Atoms		ZeroOcc	AltConf
3	A	34	Total	O	0	0
			34	34		
3	B	41	Total	O	0	0
			41	41		
3	C	30	Total	O	0	0
			30	30		
3	D	30	Total	O	0	0
			30	30		

### 3 Residue-property plots

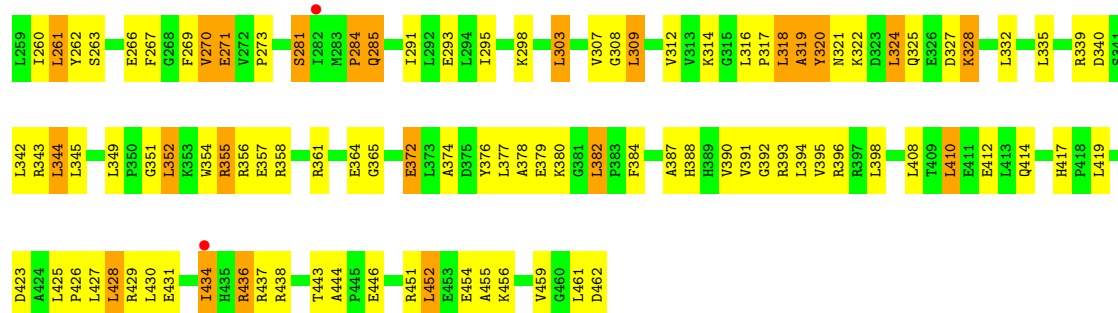
These plots are drawn for all protein, RNA, DNA and oligosaccharide chains in the entry. The first graphic for a chain summarises the proportions of the various outlier classes displayed in the second graphic. The second graphic shows the sequence view annotated by issues in geometry and electron density. 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: Argininosuccinate lyase

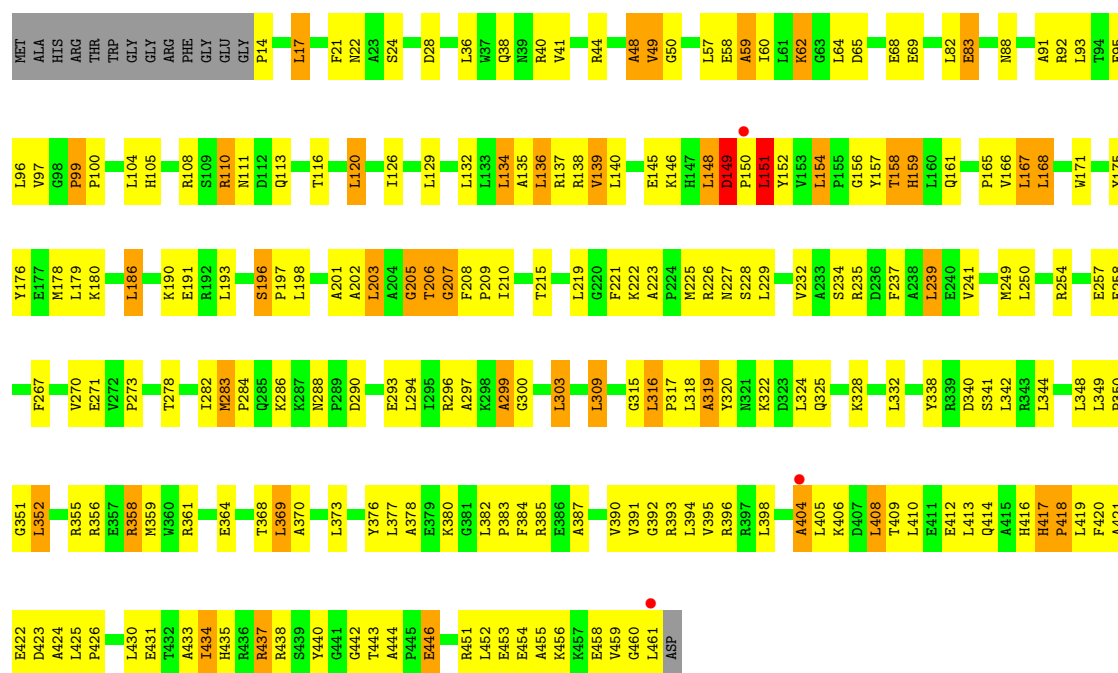


#### • Molecule 1: Argininosuccinate lyase

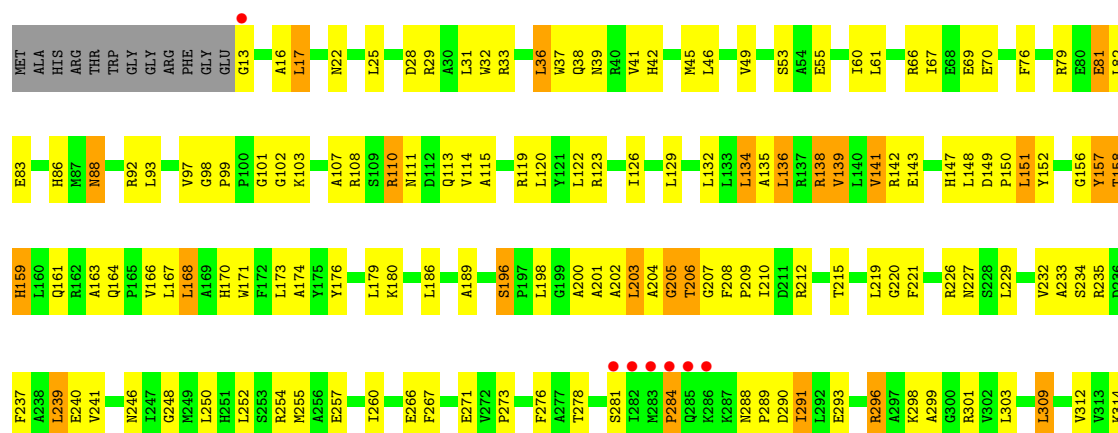




• Molecule 1: Argininosuccinate lyase



• Molecule 1: Argininosuccinate lyase



G315	L316	P317	L318	A319	Y320	N321	K322	D323	L324	D327	K328	E329	P330	L331	L332	D333	L344	L345	L348	L349	P350	G351	L352	K353	W354	R355	R356	E357	W360	E364	Y367	E372	L373	A374	A378	L382	P383	F384	R385	E386	A387	H388	V391	G392	R393	L394	V395	R396	R397
E400	E401	G402	L405	L408	T409	L410	E411	E412	L413	H417	P418	L419	F420	A421	E422	D423	A424	L425	P426	R429	L430	E431	T432	A433	L434	H435	R436	R437	R438	T443	A444	P445	E446	E450	R451	L452	E453	K456	K457	E458	V459	G460	L461	ASP					



## 4 Data and refinement statistics

Property	Value	Source
Space group	P 21 21 21	Depositor
Cell constants a, b, c, $\alpha$ , $\beta$ , $\gamma$	78.34Å 119.79Å 257.84Å 90.00° 90.00° 90.00°	Depositor
Resolution (Å)	34.29 – 2.80 34.29 – 2.80	Depositor EDS
% Data completeness (in resolution range)	85.6 (34.29-2.80) 85.6 (34.29-2.80)	Depositor EDS
$R_{merge}$	(Not available)	Depositor
$R_{sym}$	(Not available)	Depositor
$\langle I/\sigma(I) \rangle$ <sup>1</sup>	3.95 (at 2.81Å)	Xtriage
Refinement program	CNS 1.1	Depositor
R, $R_{free}$	0.205 , 0.271 0.206 , 0.270	Depositor DCC
$R_{free}$ test set	5234 reflections (10.08%)	wwPDB-VP
Wilson B-factor (Å <sup>2</sup> )	50.7	Xtriage
Anisotropy	0.404	Xtriage
Bulk solvent $k_{sol}$ (e/Å <sup>3</sup> ), $B_{sol}$ (Å <sup>2</sup> )	0.30 , 42.3	EDS
L-test for twinning <sup>2</sup>	$\langle  L  \rangle = 0.50$ , $\langle L^2 \rangle = 0.33$	Xtriage
Estimated twinning fraction	No twinning to report.	Xtriage
$F_o, F_c$ correlation	0.94	EDS
Total number of atoms	14218	wwPDB-VP
Average B, all atoms (Å <sup>2</sup> )	43.0	wwPDB-VP

Xtriage's analysis on translational NCS is as follows: *The largest off-origin peak in the Patterson function is 3.08% 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 [i](#)

### 5.1 Standard geometry [i](#)

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	0.49	0/3600	0.99	17/4877 (0.3%)
1	B	0.50	0/3597	1.00	21/4873 (0.4%)
1	C	0.49	0/3568	1.01	20/4839 (0.4%)
1	D	0.47	0/3548	1.01	20/4814 (0.4%)
All	All	0.49	0/14313	1.00	78/19403 (0.4%)

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	B	0	1

There are no bond length outliers.

The worst 5 of 78 bond angle outliers are listed below:

Mol	Chain	Res	Type	Atoms	Z	Observed( $^{\circ}$ )	Ideal( $^{\circ}$ )
1	A	413	LEU	N-CA-C	-9.58	100.40	111.03
1	D	318	LEU	N-CA-C	9.23	121.76	110.41
1	B	149	ASP	CA-C-N	-8.29	109.48	119.84
1	B	149	ASP	C-N-CA	-8.29	109.48	119.84
1	D	196	SER	N-CA-C	8.15	119.92	109.65

There are no chirality outliers.

All (1) planarity outliers are listed below:

Mol	Chain	Res	Type	Group
1	B	320	TYR	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	A	3530	0	3538	233	0
1	B	3528	0	3530	220	0
1	C	3498	0	3495	202	0
1	D	3479	0	3456	204	0
2	B	48	0	48	22	0
3	A	34	0	0	1	0
3	B	41	0	0	2	0
3	C	30	0	0	1	0
3	D	30	0	0	3	0
All	All	14218	0	14067	780	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 28.

The worst 5 of 780 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:59:ALA:HB1	1:B:97:VAL:HG21	1.32	1.11
1:A:456:LYS:HB3	1:A:461:LEU:HB3	1.28	1.05
1:B:167:LEU:HD13	1:B:443:THR:HG22	1.42	1.02
1:A:167:LEU:H	1:A:443:THR:HG21	1.26	0.99
1:C:99:PRO:HG2	1:C:100:PRO:HD3	1.43	0.98

There are no symmetry-related clashes.

## 5.3 Torsion angles

### 5.3.1 Protein backbone

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	447/462 (97%)	401 (90%)	34 (8%)	12 (3%)	4	15
1	B	448/462 (97%)	410 (92%)	30 (7%)	8 (2%)	6	23
1	C	446/462 (96%)	400 (90%)	34 (8%)	12 (3%)	4	15
1	D	447/462 (97%)	395 (88%)	44 (10%)	8 (2%)	6	23
All	All	1788/1848 (97%)	1606 (90%)	142 (8%)	40 (2%)	5	19

5 of 40 Ramachandran outliers are listed below:

Mol	Chain	Res	Type
1	A	282	ILE
1	A	319	ALA
1	B	149	ASP
1	B	205	GLY
1	C	203	LEU

### 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	
1	A	353/369 (96%)	321 (91%)	32 (9%)	9	28
1	B	351/369 (95%)	317 (90%)	34 (10%)	8	25
1	C	348/369 (94%)	311 (89%)	37 (11%)	6	22
1	D	340/369 (92%)	299 (88%)	41 (12%)	5	16
All	All	1392/1476 (94%)	1248 (90%)	144 (10%)	7	23

5 of 144 residues with a non-rotameric sidechain are listed below:

Mol	Chain	Res	Type
1	D	168	LEU
1	D	461	LEU
1	D	239	LEU
1	D	356	ARG
1	B	206	THR

Sometimes sidechains can be flipped to improve hydrogen bonding and reduce clashes. 5 of 41 such sidechains are listed below:

Mol	Chain	Res	Type
1	C	246	ASN
1	D	147	HIS
1	C	285	GLN
1	D	38	GLN
1	D	170	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](#)

4 ligands 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	$\# Z  > 2$
2	ARG	B	491	-	10,11,11	0.68	0	9,13,13	0.65	0
2	ARG	B	494	-	10,11,11	0.66	0	9,13,13	0.56	0
2	ARG	B	493	-	10,11,11	0.65	0	9,13,13	0.91	0
2	ARG	B	492	-	10,11,11	0.59	0	9,13,13	0.90	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
2	ARG	B	491	-	-	1/11/11/11	-
2	ARG	B	494	-	-	1/11/11/11	-
2	ARG	B	493	-	-	1/11/11/11	-
2	ARG	B	492	-	-	1/11/11/11	-

There are no bond length outliers.

There are no bond angle outliers.

There are no chirality outliers.

All (4) torsion outliers are listed below:

Mol	Chain	Res	Type	Atoms
2	B	494	ARG	NE-CD-CG-CB
2	B	493	ARG	NE-CD-CG-CB
2	B	491	ARG	NE-CD-CG-CB
2	B	492	ARG	NE-CD-CG-CB

There are no ring outliers.

4 monomers are involved in 22 short contacts:

Mol	Chain	Res	Type	Clashes	Symm-Clashes
2	B	491	ARG	6	0
2	B	494	ARG	5	0
2	B	493	ARG	3	0
2	B	492	ARG	8	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, 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	449/462 (97%)	-0.24	4 (0%) 81 74	25, 42, 58, 81	0
1	B	450/462 (97%)	-0.31	4 (0%) 81 74	22, 38, 57, 79	0
1	C	448/462 (96%)	-0.24	3 (0%) 84 77	25, 42, 64, 72	0
1	D	449/462 (97%)	-0.12	7 (1%) 70 61	28, 45, 60, 77	0
All	All	1796/1848 (97%)	-0.23	18 (1%) 79 72	22, 42, 62, 81	0

The worst 5 of 18 RSRZ outliers are listed below:

Mol	Chain	Res	Type	RSRZ
1	D	285	GLN	3.8
1	A	150	PRO	3.1
1	D	282	ILE	3.1
1	D	13	GLY	2.9
1	A	282	ILE	2.7

### 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 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, 95<sup>th</sup> 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
2	ARG	B	492	12/12	0.82	0.15	45,49,50,51	0
2	ARG	B	494	12/12	0.85	0.14	42,46,48,49	0
2	ARG	B	493	12/12	0.86	0.16	33,43,50,51	0
2	ARG	B	491	12/12	0.86	0.14	33,35,38,40	0

## 6.5 Other polymers [i](#)

There are no such residues in this entry.