



Full wwPDB X-ray Structure Validation Report ⓘ

Mar 6, 2026 – 10:55 AM UTC

PDB ID : 6NCS / pdb_00006ncs
Title : Crystal structure of N-acetylneuraminic acid (Sialic acid) synthetase from *Leptospira borgpetersenii* serovar Hardjo-bovis in complex with citrate
Authors : Seattle Structural Genomics Center for Infectious Disease (SSGCID)
Deposited on : 2018-12-12
Resolution : 1.80 Å(reported)

This is a Full wwPDB X-ray Structure Validation Report for a publicly released PDB entry.

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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
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

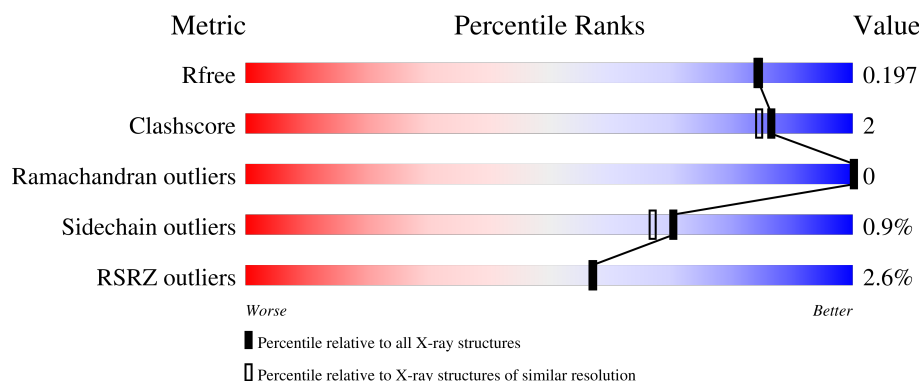
1 Overall quality at a glance

The following experimental techniques were used to determine the structure:

X-RAY DIFFRACTION

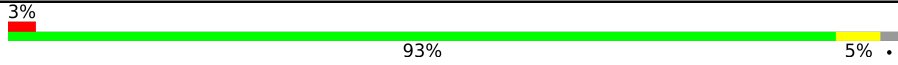
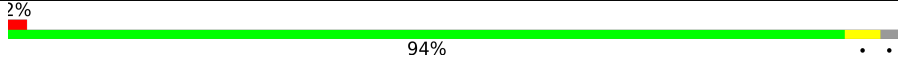
The reported resolution of this entry is 1.80 Å.

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	7662 (1.80-1.80)
Clashscore	190562	8479 (1.80-1.80)
Ramachandran outliers	187476	8391 (1.80-1.80)
Sidechain outliers	187428	8390 (1.80-1.80)
RSRZ outliers	180081	7663 (1.80-1.80)

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 ≥ 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	290	
1	B	290	

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
6	TAR	A	305	-	X	-	-
7	IOD	A	310	-	-	X	-

2 Entry composition

There are 8 unique types of molecules in this entry. The entry contains 5030 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 N-acetylneuraminic acid (Sialic acid) synthetase.

Mol	Chain	Residues	Atoms					ZeroOcc	AltConf	Trace
1	A	285	Total	C	N	O	S	0	11	0
			2231	1419	376	429	7			
1	B	285	Total	C	N	O	S	0	10	0
			2207	1404	367	430	6			

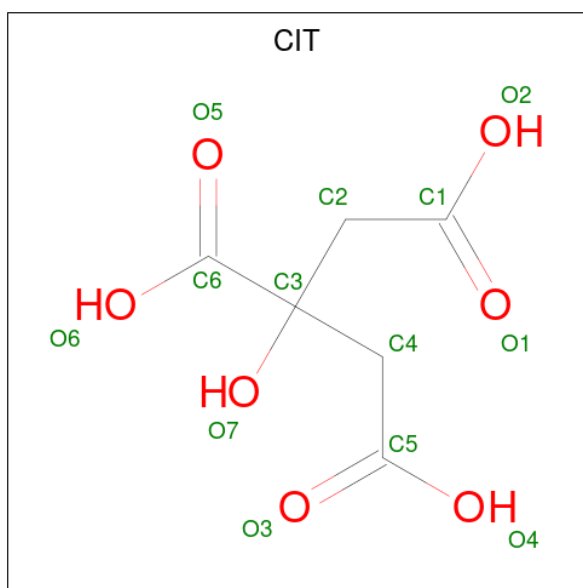
There are 16 discrepancies between the modelled and reference sequences:

Chain	Residue	Modelled	Actual	Comment	Reference
A	-7	MET	-	initiating methionine	UNP Q04TM5
A	-6	ALA	-	expression tag	UNP Q04TM5
A	-5	HIS	-	expression tag	UNP Q04TM5
A	-4	HIS	-	expression tag	UNP Q04TM5
A	-3	HIS	-	expression tag	UNP Q04TM5
A	-2	HIS	-	expression tag	UNP Q04TM5
A	-1	HIS	-	expression tag	UNP Q04TM5
A	0	HIS	-	expression tag	UNP Q04TM5
B	-7	MET	-	initiating methionine	UNP Q04TM5
B	-6	ALA	-	expression tag	UNP Q04TM5
B	-5	HIS	-	expression tag	UNP Q04TM5
B	-4	HIS	-	expression tag	UNP Q04TM5
B	-3	HIS	-	expression tag	UNP Q04TM5
B	-2	HIS	-	expression tag	UNP Q04TM5
B	-1	HIS	-	expression tag	UNP Q04TM5
B	0	HIS	-	expression tag	UNP Q04TM5

- Molecule 2 is MANGANESE (II) ION (CCD ID: MN) (formula: Mn).

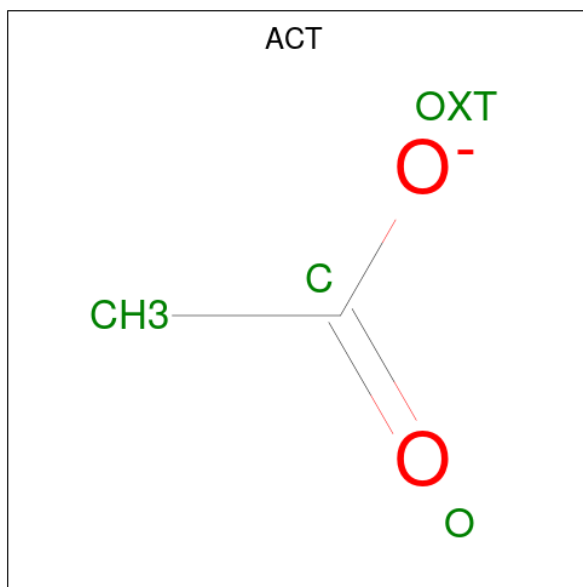
Mol	Chain	Residues	Atoms		ZeroOcc	AltConf
2	A	1	Total	Mn	0	0
			1	1		
2	B	1	Total	Mn	0	0
			1	1		

- Molecule 3 is CITRIC ACID (CCD ID: CIT) (formula: $C_6H_8O_7$).



Mol	Chain	Residues	Atoms			ZeroOcc	AltConf
3	A	1	Total	C	O	0	0
			13	6	7		
3	B	1	Total	C	O	0	0
			13	6	7		

- Molecule 4 is ACETATE ION (CCD ID: ACT) (formula: $C_2H_3O_2$).



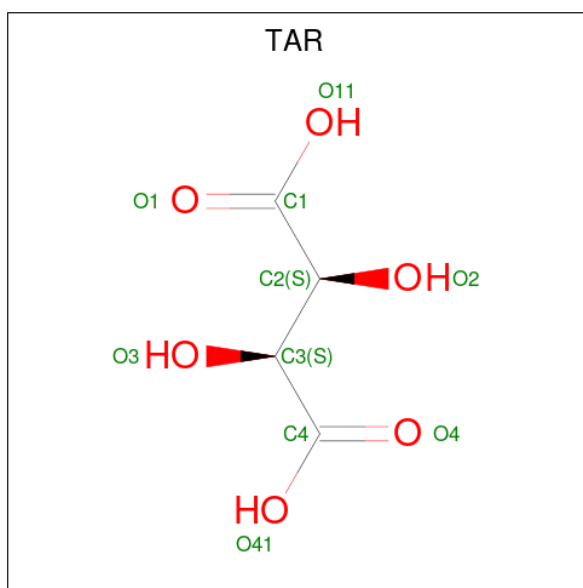
Mol	Chain	Residues	Atoms			ZeroOcc	AltConf
4	A	1	Total	C	O	0	0
			4	2	2		

- Molecule 5 is FORMIC ACID (CCD ID: FMT) (formula: CH_2O_2).



Mol	Chain	Residues	Atoms			ZeroOcc	AltConf
5	A	1	Total	C	O	0	0
			3	1	2		

- Molecule 6 is D(-)-TARTARIC ACID (CCD ID: TAR) (formula: $\text{C}_4\text{H}_6\text{O}_6$).



Mol	Chain	Residues	Atoms			ZeroOcc	AltConf
6	A	1	Total	C	O	0	0
			10	4	6		

- Molecule 7 is IODIDE ION (CCD ID: IOD) (formula: I).

Mol	Chain	Residues	Atoms		ZeroOcc	AltConf
7	A	10	Total 12	I 12	0	2
7	B	10	Total 11	I 11	0	1

- Molecule 8 is water.

Mol	Chain	Residues	Atoms		ZeroOcc	AltConf
8	A	259	Total 264	O 264	0	4
8	B	259	Total 260	O 260	0	1

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: N-acetylneuraminic acid (Sialic acid) synthetase



- Molecule 1: N-acetylneuraminic acid (Sialic acid) synthetase



4 Data and refinement statistics

Property	Value	Source
Space group	P 1 21 1	Depositor
Cell constants a, b, c, α , β , γ	69.88Å 49.12Å 88.85Å 90.00° 112.41° 90.00°	Depositor
Resolution (Å)	43.38 – 1.80 43.38 – 1.80	Depositor EDS
% Data completeness (in resolution range)	97.2 (43.38-1.80) 97.2 (43.38-1.80)	Depositor EDS
R_{merge}	0.06	Depositor
R_{sym}	(Not available)	Depositor
$\langle I/\sigma(I) \rangle$ ¹	4.29 (at 1.79Å)	Xtriage
Refinement program	PHENIX dev_3339	Depositor
R, R_{free}	0.156 , 0.198 0.156 , 0.197	Depositor DCC
R_{free} test set	2017 reflections (3.88%)	wwPDB-VP
Wilson B-factor (Å ²)	18.9	Xtriage
Anisotropy	0.317	Xtriage
Bulk solvent k_{sol} (e/Å ³), B_{sol} (Å ²)	0.32 , 45.7	EDS
L-test for twinning ²	$\langle L \rangle = 0.51$, $\langle L^2 \rangle = 0.34$	Xtriage
Estimated twinning fraction	0.012 for h,-k,-h-l	Xtriage
F_o, F_c correlation	0.96	EDS
Total number of atoms	5030	wwPDB-VP
Average B, all atoms (Å ²)	25.0	wwPDB-VP

Xtriage's analysis on translational NCS is as follows: *The largest off-origin peak in the Patterson function is 5.62% of the height of the origin peak. No significant pseudotranslation is detected.*

¹Intensities estimated from amplitudes.

²Theoretical 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](#)

Bond lengths and bond angles in the following residue types are not validated in this section: TAR, ACT, CIT, FMT, MN, IOD

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	0.25	0/2305	0.49	0/3111
1	B	0.25	0/2271	0.49	0/3073
All	All	0.25	0/4576	0.49	0/6184

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 [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	2231	0	2252	11	0
1	B	2207	0	2205	9	0
2	A	1	0	0	0	0
2	B	1	0	0	0	0
3	A	13	0	4	0	0
3	B	13	0	4	0	0
4	A	4	0	3	0	0
5	A	3	0	1	0	0
6	A	10	0	4	0	0
7	A	12	0	0	5	0
7	B	11	0	0	1	0

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Mol	Chain	Non-H	H(model)	H(added)	Clashes	Symm-Clashes
8	A	264	0	0	1	0
8	B	260	0	0	3	0
All	All	5030	0	4473	19	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 2.

All (19) 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:-2:HIS:N	1:A:260:HIS:O	2.18	0.75
1:B:-2:HIS:N	1:B:260:HIS:O	2.22	0.66
1:B:69:ASN:OD1	8:B:401:HOH:O	2.15	0.64
1:A:89[A]:GLN:HG2	7:A:307:IOD:I	2.72	0.59
1:A:-1[A]:HIS:HB2	1:B:188:THR:HG23	1.89	0.53
1:A:38:MET:HG2	1:A:226:VAL:HG13	1.93	0.51
1:A:90:LYS:HE2	7:A:313:IOD:I	2.82	0.50
1:B:107:MET:HA	7:B:305:IOD:I	2.82	0.50
1:A:85:LYS:O	1:A:89[A]:GLN:HG3	2.15	0.46
1:B:38:MET:HG2	1:B:226[A]:VAL:HG13	1.97	0.46
1:A:243:GLU:OE1	7:A:310:IOD:I	3.05	0.45
1:A:252:GLU:HG3	8:A:567:HOH:O	2.16	0.45
1:A:107:MET:HA	7:A:308:IOD:I	2.87	0.44
1:A:1:MET:HG3	1:A:14:GLY:HA2	1.99	0.44
1:B:191[B]:SER:OG	8:B:402:HOH:O	2.20	0.44
1:B:174:TYR:O	8:B:403:HOH:O	2.21	0.44
1:A:205:GLY:HA2	7:A:310:IOD:I	2.89	0.42
1:B:37:ARG:CZ	1:B:226[B]:VAL:HG11	2.50	0.41
1:B:206:ILE:C	1:B:209:PRO:HD2	2.46	0.41

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	295/290 (102%)	290 (98%)	5 (2%)	0	100	100
1	B	293/290 (101%)	290 (99%)	3 (1%)	0	100	100
All	All	588/580 (101%)	580 (99%)	8 (1%)	0	100	100

There are no Ramachandran outliers to report.

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	241/245 (98%)	239 (99%)	2 (1%)	73	70
1	B	235/245 (96%)	233 (99%)	2 (1%)	70	67
All	All	476/490 (97%)	472 (99%)	4 (1%)	70	70

All (4) residues with a non-rotameric sidechain are listed below:

Mol	Chain	Res	Type
1	A	-2	HIS
1	A	143	ARG
1	B	-2	HIS
1	B	143	ARG

Sometimes sidechains can be flipped to improve hydrogen bonding and reduce clashes. All (4) such sidechains are listed below:

Mol	Chain	Res	Type
1	A	3	GLN
1	A	177	ASN
1	B	3	GLN
1	B	266	GLN

5.3.3 RNA ⓘ

There are no RNA molecules in this entry.

5.4 Non-standard residues in protein, DNA, RNA chains ⓘ

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

5.5 Carbohydrates ⓘ

There are no oligosaccharides in this entry.

5.6 Ligand geometry ⓘ

Of 30 ligands modelled in this entry, 25 are monoatomic - leaving 5 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	$\# Z > 2$
6	TAR	A	305	-	9,9,9	1.34	1 (11%)	12,12,12	1.61	2 (16%)
5	FMT	A	304	-	2,2,2	0.73	0	1,1,1	0.22	0
3	CIT	A	302	2	12,12,12	1.05	0	17,17,17	1.73	3 (17%)
3	CIT	B	302	2	12,12,12	1.11	0	17,17,17	1.52	1 (5%)
4	ACT	A	303	-	3,3,3	1.50	1 (33%)	3,3,3	1.50	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
6	TAR	A	305	-	-	12/12/12/12	-
3	CIT	A	302	2	-	6/16/16/16	-
3	CIT	B	302	2	-	1/16/16/16	-

All (2) bond length outliers are listed below:

Mol	Chain	Res	Type	Atoms	Z	Observed(Å)	Ideal(Å)
6	A	305	TAR	C2-C1	-2.28	1.49	1.52
4	A	303	ACT	CH3-C	2.16	1.57	1.49

All (6) bond angle outliers are listed below:

Mol	Chain	Res	Type	Atoms	Z	Observed(°)	Ideal(°)
3	B	302	CIT	O6-C6-C3	3.96	120.74	113.14
3	A	302	CIT	O6-C6-C3	3.91	120.64	113.14
6	A	305	TAR	O2-C2-C1	-2.92	104.44	110.69
6	A	305	TAR	O41-C4-C3	2.71	120.83	113.31
3	A	302	CIT	O2-C1-C2	2.67	122.80	114.35
3	A	302	CIT	O4-C5-C4	2.63	122.69	114.35

There are no chirality outliers.

All (19) torsion outliers are listed below:

Mol	Chain	Res	Type	Atoms
6	A	305	TAR	O1-C1-C2-O2
6	A	305	TAR	O11-C1-C2-O2
6	A	305	TAR	C1-C2-C3-O3
6	A	305	TAR	C1-C2-C3-C4
6	A	305	TAR	O2-C2-C3-O3
6	A	305	TAR	O2-C2-C3-C4
6	A	305	TAR	O11-C1-C2-C3
6	A	305	TAR	C2-C3-C4-O41
6	A	305	TAR	O3-C3-C4-O4
6	A	305	TAR	O1-C1-C2-C3
6	A	305	TAR	C2-C3-C4-O4
6	A	305	TAR	O3-C3-C4-O41
3	A	302	CIT	C2-C3-C6-O5
3	A	302	CIT	C3-C4-C5-O4
3	A	302	CIT	C3-C4-C5-O3
3	A	302	CIT	C2-C3-C6-O6
3	A	302	CIT	C4-C3-C6-O5
3	A	302	CIT	C4-C3-C6-O6
3	B	302	CIT	C2-C3-C6-O6

There are no ring outliers.

No monomer is involved in short contacts.

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	285/290 (98%)	-0.39	8 (2%) 55 55	9, 21, 39, 68	11 (3%)
1	B	285/290 (98%)	-0.37	7 (2%) 58 58	8, 20, 44, 68	10 (3%)
All	All	570/580 (98%)	-0.38	15 (2%) 57 57	8, 21, 41, 68	21 (3%)

All (15) RSRZ outliers are listed below:

Mol	Chain	Res	Type	RSRZ
1	A	-2	HIS	5.8
1	B	-2	HIS	5.1
1	B	-1	HIS	4.5
1	B	10	ILE	4.0
1	A	-1[A]	HIS	3.9
1	A	7	LEU	3.6
1	A	10	ILE	3.4
1	B	0	HIS	2.8
1	A	0	HIS	2.7
1	A	1	MET	2.5
1	A	8	GLY	2.3
1	B	70	LEU	2.3
1	B	9	ASN	2.2
1	B	1	MET	2.2
1	A	6	THR	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 oligosaccharides in this entry.

6.4 Ligands

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, 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	B-factors(Å ²)	Q<0.9
4	ACT	A	303	4/4	0.70	0.19	45,54,55,60	0
7	IOD	A	315	1/1	0.71	0.27	115,115,115,115	1
7	IOD	B	311	1/1	0.74	0.33	91,91,91,91	1
6	TAR	A	305	10/10	0.75	0.20	35,46,53,56	10
7	IOD	B	310	1/1	0.76	0.30	131,131,131,131	0
7	IOD	A	309	1/1	0.76	0.28	101,101,101,101	1
5	FMT	A	304	3/3	0.84	0.11	53,53,54,54	0
7	IOD	B	305	1/1	0.85	0.14	49,49,49,49	1
7	IOD	A	313	1/1	0.85	0.20	98,98,98,98	1
3	CIT	B	302	13/13	0.85	0.14	20,40,48,52	13
7	IOD	B	312	1/1	0.86	0.24	89,89,89,89	1
7	IOD	A	308	1/1	0.88	0.15	65,65,65,65	1
7	IOD	A	307	1/1	0.89	0.15	75,75,75,75	1
3	CIT	A	302	13/13	0.89	0.10	22,33,41,44	13
7	IOD	A	306	1/1	0.89	0.12	50,50,50,50	1
7	IOD	A	312[A]	1/1	0.93	0.12	57,57,57,57	1
7	IOD	A	312[B]	1/1	0.93	0.12	85,85,85,85	1
7	IOD	B	307[A]	1/1	0.94	0.08	45,45,45,45	1
7	IOD	B	307[B]	1/1	0.94	0.08	96,96,96,96	1
7	IOD	B	309	1/1	0.94	0.08	41,41,41,41	1
7	IOD	B	306	1/1	0.96	0.07	35,35,35,35	1
7	IOD	B	304	1/1	0.96	0.06	37,37,37,37	1
7	IOD	B	303	1/1	0.96	0.08	49,49,49,49	1
7	IOD	B	308	1/1	0.96	0.07	49,49,49,49	1
7	IOD	A	311[B]	1/1	0.98	0.06	46,46,46,46	1
7	IOD	A	311[A]	1/1	0.98	0.06	37,37,37,37	1
7	IOD	A	314	1/1	0.98	0.05	32,32,32,32	1
2	MN	B	301	1/1	0.99	0.08	29,29,29,29	1
2	MN	A	301	1/1	0.99	0.02	19,19,19,19	1
7	IOD	A	310	1/1	0.99	0.06	41,41,41,41	1

6.5 Other polymers

There are no such residues in this entry.