



# Full wwPDB X-ray Structure Validation Report

Oct 3, 2014 – 05:28 AM EDT

PDB ID : 4CWA  
Title : Structure of Plasmodium Falciparum Spermidine Synthase in Complex with 1  
H-Benzimidazole-2-pentanamine  
Authors : Sprenger, J.; Halander, J.C.; Svensson, B.; Al-Karadaghi, S.; Persson, L.  
Deposited on : 2014-04-01  
Resolution : 2.02 Å(reported)

This is a full wwPDB validation 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 <http://wwpdb.org/ValidationPDFNotes.html>

---

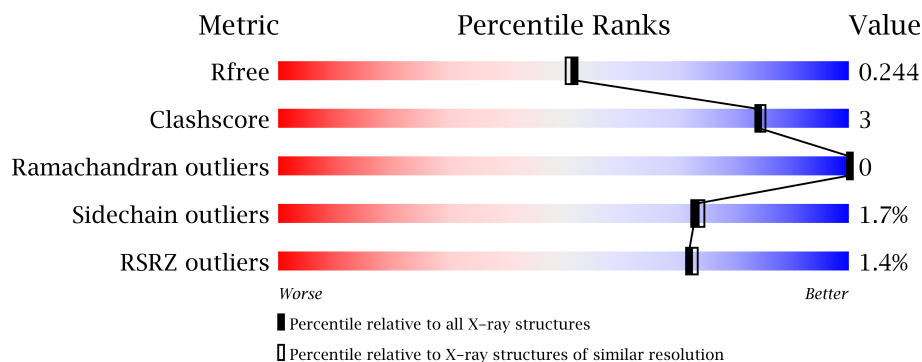
The following versions of software and data (see [references](#)) were used in the production of this report:

MolProbity : 4.02b-467  
Mogul : 1.16 November 2013  
Xtriage (Phenix) : dev-1439  
EDS : stable23828  
Percentile statistics : 21963  
Refmac : 5.8.0049  
CCP4 : 6.3.0 (Settle)  
Ideal geometry (proteins) : Engh & Huber (2001)  
Ideal geometry (DNA, RNA) : Parkinson et. al. (1996)  
Validation Pipeline (wwPDB-VP) : stable23828

# 1 Overall quality at a glance

The reported resolution of this entry is 2.02 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))
$R_{free}$	66092	6003 (2.04-2.00)
Clashscore	79885	7467 (2.04-2.00)
Ramachandran outliers	78287	7370 (2.04-2.00)
Sidechain outliers	78261	7368 (2.04-2.00)
RSRZ outliers	66119	6006 (2.04-2.00)

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. The upper red bar (where present) indicates the fraction of residues that have poor fit to the electron density.

Mol	Chain	Length	Quality of chain
1	A	283	
1	B	283	
1	C	283	

The following table lists non-polymeric compounds that are outliers for geometric or electron-density-fit criteria:

Mol	Type	Chain	Res	Geometry	Electron density
2	JA2	A	601	-	X
2	JA2	C	601	-	X
3	1PG	B	601	-	X

## 2 Entry composition i

There are 4 unique types of molecules in this entry. The entry contains 7060 atoms, of which 0 are hydrogen and 0 are deuterium.

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.

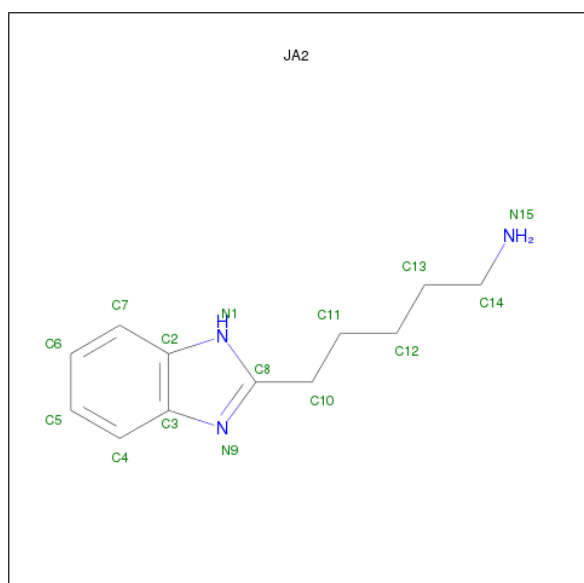
- Molecule 1 is a protein called SPERMIDINE SYNTHASE.

Mol	Chain	Residues	Atoms					ZeroOcc	AltConf	Trace
1	A	281	Total	C	N	O	S	0	0	0
			2254	1463	352	425	14			
1	B	267	Total	C	N	O	S	0	1	0
			2151	1397	336	404	14			
1	C	281	Total	C	N	O	S	0	1	0
			2256	1463	352	427	14			

There are 3 discrepancies between the modelled and reference sequences:

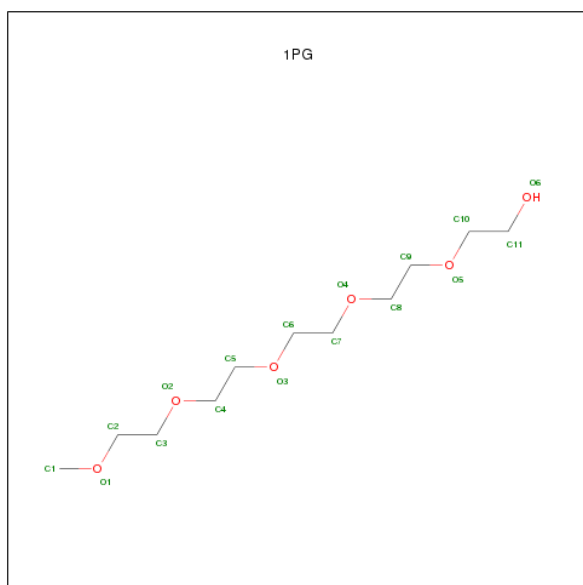
Chain	Residue	Modelled	Actual	Comment	Reference
A	39	GLY	-	EXPRESSION TAG	UNP Q8II73
B	39	GLY	-	EXPRESSION TAG	UNP Q8II73
C	39	GLY	-	EXPRESSION TAG	UNP Q8II73

- Molecule 2 is 5-(1H-BENZIMIDAZOL-2-YL)PENTAN-1-AMINE (three-letter code: JA2) (formula: C<sub>12</sub>H<sub>17</sub>N<sub>3</sub>).



Mol	Chain	Residues	Atoms			ZeroOcc	AltConf
2	A	1	Total	C	N	0	0
			15	12	3		
2	C	1	Total	C	N	0	0
			15	12	3		

- Molecule 3 is 2-(2-{2-[2-(2-METHOXY-ETHOXY)-ETHOXY]-ETHOXY}-ETHOXY)-ETHANOL (three-letter code: 1PG) (formula: C<sub>11</sub>H<sub>24</sub>O<sub>6</sub>).



Mol	Chain	Residues	Atoms			ZeroOcc	AltConf
3	B	1	Total	C	O	0	0
			17	11	6		

- Molecule 4 is water.

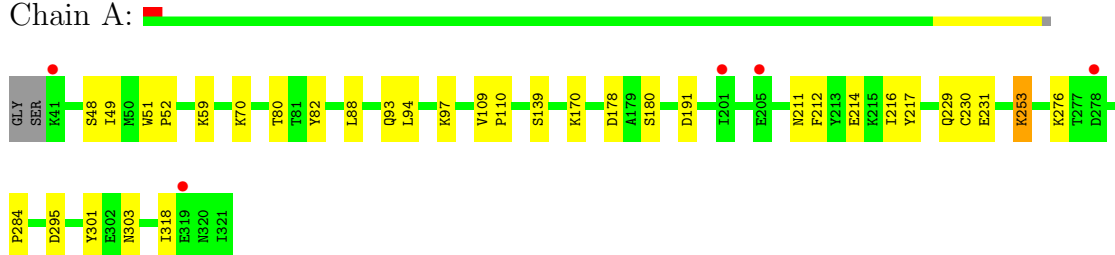
Mol	Chain	Residues	Atoms		ZeroOcc	AltConf
4	A	83	Total	O	0	0
			83	83		
4	B	120	Total	O	0	0
			120	120		
4	C	149	Total	O	0	0
			149	149		

### 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.

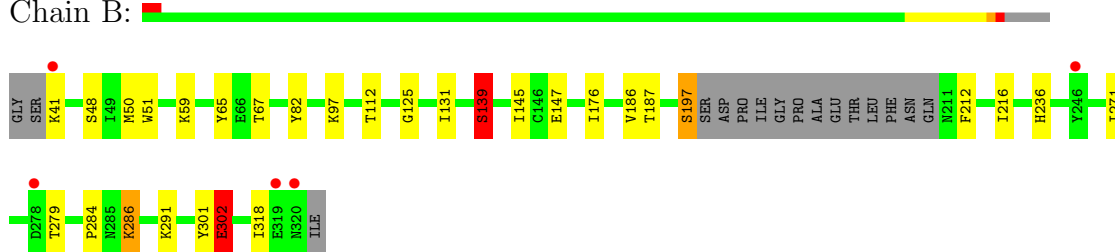
#### • Molecule 1: SPERMIDINE SYNTHASE

Chain A:



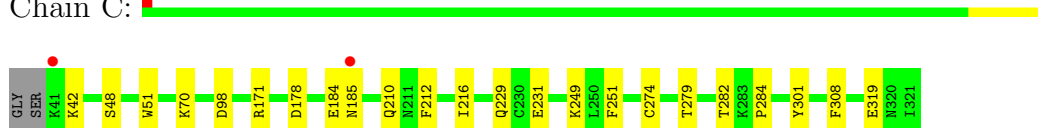
#### • Molecule 1: SPERMIDINE SYNTHASE

Chain B:



#### • Molecule 1: SPERMIDINE SYNTHASE

Chain C:



## 4 Data and refinement statistics

Property	Value	Source
Space group	C 1 2 1	Depositor
Cell constants a, b, c, $\alpha$ , $\beta$ , $\gamma$	197.50Å 134.38Å 48.28Å 90.00° 94.53° 90.00°	Depositor
Resolution (Å)	26.63 – 2.02 26.63 – 2.02	Depositor EDS
% Data completeness (in resolution range)	98.4 (26.63-2.02) 98.4 (26.63-2.02)	Depositor EDS
$R_{merge}$	0.08	Depositor
$R_{sym}$	(Not available)	Depositor
$\langle I/\sigma(I) \rangle$ <sup>1</sup>	3.91 (at 2.03Å)	Xtriage
Refinement program	REFMAC 5.7.0029	Depositor
R, $R_{free}$	0.205 , 0.241 0.213 , 0.244	Depositor DCC
$R_{free}$ test set	4037 reflections (5.26%)	DCC
Wilson B-factor (Å <sup>2</sup> )	18.8	Xtriage
Anisotropy	0.134	Xtriage
Bulk solvent $k_{sol}$ (e/Å <sup>3</sup> ), $B_{sol}$ (Å <sup>2</sup> )	0.41 , 37.6	EDS
Estimated twinning fraction	No twinning to report.	Xtriage
L-test for twinning	$\langle  L  \rangle = 0.49$ , $\langle L^2 \rangle = 0.32$	Xtriage
Outliers	2 of 80731 reflections (0.002%)	Xtriage
$F_o, F_c$ correlation	0.91	EDS
Total number of atoms	7060	wwPDB-VP
Average B, all atoms (Å <sup>2</sup> )	23.0	wwPDB-VP

Xtriage's analysis on translational NCS is as follows: *The largest off-origin peak in the Patterson function is 3.76% of the height of the origin peak. No significant pseudotranslation is detected.*

<sup>1</sup>Intensities estimated from amplitudes.

## 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: JA2, 1PG

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	0.97	1/2304 (0.0%)	0.93	4/3111 (0.1%)
1	B	1.03	3/2197 (0.1%)	0.94	2/2964 (0.1%)
1	C	0.97	1/2306 (0.0%)	0.94	4/3115 (0.1%)
All	All	0.99	5/6807 (0.1%)	0.94	10/9190 (0.1%)

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	A	0	1

All (5) bond length outliers are listed below:

Mol	Chain	Res	Type	Atoms	Z	Observed(Å)	Ideal(Å)
1	B	125	GLY	N-CA	7.14	1.56	1.46
1	A	231	GLU	CG-CD	6.18	1.61	1.51
1	B	302	GLU	CG-CD	-6.04	1.42	1.51
1	B	139	SER	CB-OG	5.76	1.49	1.42
1	C	319	GLU	CD-OE2	5.08	1.31	1.25

All (10) bond angle outliers are listed below:

Mol	Chain	Res	Type	Atoms	Z	Observed(°)	Ideal(°)
1	A	295	ASP	CB-CG-OD1	9.32	126.69	118.30
1	C	178	ASP	CB-CG-OD1	6.81	124.43	118.30
1	C	98	ASP	CB-CG-OD1	6.48	124.13	118.30
1	A	295	ASP	CB-CG-OD2	-6.27	112.65	118.30
1	B	197	SER	CB-CA-C	-6.10	98.50	110.10

*Continued on next page...*

*Continued from previous page...*

Mol	Chain	Res	Type	Atoms	Z	Observed(°)	Ideal(°)
1	B	302	GLU	OE1-CD-OE2	5.84	130.31	123.30
1	A	303	ASN	CB-CA-C	5.70	121.80	110.40
1	C	279	THR	N-CA-C	5.67	126.30	111.00
1	A	191	ASP	CB-CG-OD1	-5.43	113.41	118.30
1	C	171	ARG	NE-CZ-NH2	-5.14	117.73	120.30

There are no chirality outliers.

All (1) planarity outliers are listed below:

Mol	Chain	Res	Type	Group
1	A	230	CYS	Peptide

## 5.2 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 hydrogens added by MolProbity. The Clashes column lists the number of clashes within the asymmetric unit, and the number in parentheses is this value normalized per 1000 atoms of the molecule in the chain. The Symm-Clashes column gives symmetry related clashes, in the same way as for the Clashes column.

Mol	Chain	Non-H	H(model)	H(added)	Clashes	Symm-Clashes
1	A	2254	0	2265	15	0
1	B	2151	0	2159	15	1
1	C	2256	0	2258	9	0
2	A	15	0	0	0	0
2	C	15	0	0	0	0
3	B	17	0	24	0	0
4	A	83	0	0	1	0
4	B	120	0	0	2	1
4	C	149	0	0	0	0
All	All	7060	0	6706	39	1

Clashscore is defined as the number of clashes calculated for the entry per 1000 atoms (including hydrogens) of the entry. The overall clashscore for this entry is 3.

All (39) close contacts within the same asymmetric unit are listed below.

Atom-1	Atom-2	Distance(Å)	Clash(Å)
1:B:139:SER:HB3	4:B:2046:HOH:O	1.94	0.68
1:B:197:SER:OG	1:B:197:SER:O	2.08	0.67
1:C:229:GLN:HE21	1:C:231:GLU:H	1.50	0.59

*Continued on next page...*



Continued from previous page...

Atom-1	Atom-2	Distance(Å)	Clash(Å)
1:A:212:PHE:CE2	1:A:216:ILE:HD11	2.38	0.59
1:B:112:THR:HA	1:B:286:LYS:HE2	1.84	0.58
1:C:184:GLU:O	1:C:185:ASN:HB2	2.06	0.56
1:B:212:PHE:CE2	1:B:216:ILE:HD11	2.43	0.53
1:C:210:GLN:NE2	1:C:249:LYS:HD2	2.24	0.52
1:A:94:LEU:HD12	1:A:94:LEU:C	2.30	0.51
1:B:41:LYS:HD2	1:B:59:LYS:HE2	1.93	0.50
1:B:65:TYR:OH	1:B:67:THR:HG21	2.12	0.50
1:B:131:ILE:HD11	1:B:145:ILE:HG21	1.93	0.50
1:B:50:MET:O	1:B:236:HIS:HE1	1.94	0.49
1:A:82:TYR:CD2	1:A:97:LYS:HD3	2.47	0.49
1:B:41:LYS:CD	1:B:59:LYS:HE2	2.42	0.49
1:A:284:PRO:HG2	1:A:301:TYR:CE1	2.47	0.49
1:C:184:GLU:O	1:C:185:ASN:CB	2.58	0.48
1:A:217:TYR:CE2	1:A:276:LYS:HE2	2.50	0.46
1:A:48:SER:HB3	1:A:51:TRP:CE2	2.51	0.45
1:B:82:TYR:CD2	1:B:97:LYS:HD3	2.51	0.45
1:C:282:THR:HG22	1:C:308:PHE:CG	2.52	0.45
1:B:284:PRO:HG2	1:B:301:TYR:CE1	2.52	0.44
1:A:88:LEU:HG	1:A:93:GLN:HG3	1.98	0.44
1:A:318:ILE:O	1:A:318:ILE:HG13	2.18	0.44
1:C:212:PHE:CE2	1:C:216:ILE:HD11	2.52	0.43
1:A:211:ASN:O	1:A:214:GLU:HB2	2.18	0.43
1:B:302:GLU:HG3	4:B:2107:HOH:O	2.17	0.43
1:C:48:SER:HB3	1:C:51:TRP:CE2	2.54	0.42
1:A:59:LYS:HD2	1:A:80:THR:HG21	2.02	0.42
1:A:178:ASP:OD2	1:A:180:SER:HB2	2.19	0.42
1:A:49:ILE:O	1:A:52:PRO:HD3	2.19	0.42
1:B:48:SER:HB3	1:B:51:TRP:CE2	2.55	0.41
1:C:251:PHE:CG	1:C:274:CYS:HB3	2.55	0.41
1:C:284:PRO:HG2	1:C:301:TYR:CE1	2.55	0.41
1:A:253:LYS:HD2	1:A:253:LYS:HA	1.76	0.41
1:B:147:GLU:O	1:B:176:ILE:HA	2.21	0.41
1:B:271:ILE:HD13	1:B:271:ILE:HG21	1.77	0.41
1:A:70:LYS:HB2	4:A:2012:HOH:O	2.21	0.40
1:A:109:VAL:HB	1:A:110:PRO:HD3	2.04	0.40

All (1) symmetry-related close contacts are listed below. The label for Atom-2 includes the symmetry operator and encoded unit-cell translations to be applied.

Atom-1	Atom-2	Distance(Å)	Clash(Å)
1:B:291:LYS:NZ	4:B:2078:HOH:O[1_554]	1.77	0.43

## 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	279/283 (99%)	269 (96%)	10 (4%)	0	100	100
1	B	264/283 (93%)	256 (97%)	8 (3%)	0	100	100
1	C	280/283 (99%)	272 (97%)	8 (3%)	0	100	100
All	All	823/849 (97%)	797 (97%)	26 (3%)	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	253/254 (100%)	249 (98%)	4 (2%)	75	76
1	B	241/254 (95%)	234 (97%)	7 (3%)	55	51
1	C	253/254 (100%)	251 (99%)	2 (1%)	89	91
All	All	747/762 (98%)	734 (98%)	13 (2%)	73	74

All (13) residues with a non-rotameric sidechain are listed below:

Mol	Chain	Res	Type
1	A	139	SER
1	A	170	LYS
1	A	229	GLN
1	A	253	LYS
1	B	139	SER
1	B	186	VAL
1	B	187	THR

*Continued on next page...*

*Continued from previous page...*

Mol	Chain	Res	Type
1	B	279	THR
1	B	286	LYS
1	B	302	GLU
1	B	318	ILE
1	C	42	LYS
1	C	70	LYS

Some sidechains can be flipped to improve hydrogen bonding and reduce clashes. All (12) such sidechains are listed below:

Mol	Chain	Res	Type
1	A	93	GLN
1	A	142	ASN
1	A	210	GLN
1	A	218	ASN
1	B	142	ASN
1	B	236	HIS
1	B	285	ASN
1	C	73	ASN
1	C	210	GLN
1	C	211	ASN
1	C	229	GLN
1	C	285	ASN

### 5.3.3 RNA ⓘ

There are no RNA chains 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 carbohydrates in this entry.

## 5.6 Ligand geometry ⓘ

3 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	JA2	A	601	-	16,16,16	1.03	1 (6%)	20,20,20	1.34	1 (5%)
3	1PG	B	601	-	16,16,16	0.53	0	15,15,15	0.63	0
2	JA2	C	601	-	16,16,16	1.08	1 (6%)	20,20,20	2.40	4 (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
2	JA2	A	601	-	-	0/6/6/6	0/2/2/2
3	1PG	B	601	-	-	0/14/14/14	0/0/0/0
2	JA2	C	601	-	-	0/6/6/6	0/2/2/2

All (2) bond length outliers are listed below:

Mol	Chain	Res	Type	Atoms	Z	Observed(Å)	Ideal(Å)
2	C	601	JA2	C6-C5	2.24	1.43	1.38
2	A	601	JA2	C6-C7	2.23	1.41	1.36

All (5) bond angle outliers are listed below:

Mol	Chain	Res	Type	Atoms	Z	Observed(°)	Ideal(°)
2	C	601	JA2	C11-C10-C8	8.43	130.21	112.21
2	A	601	JA2	C11-C10-C8	-4.95	101.65	112.21
2	C	601	JA2	C12-C11-C10	4.16	131.16	113.95
2	C	601	JA2	C3-C2-N1	3.44	108.84	105.86
2	C	601	JA2	C10-C8-N9	2.05	126.44	123.95

There are no chirality outliers.

There are no torsion outliers.

There are no ring outliers.

## 5.7 Other polymers ⓘ

There are no such residues in this entry.

## 5.8 Polymer linkage issues

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<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	281/283 (99%)	-0.00	5 (1%) 65 66	17, 25, 47, 58	0
1	B	267/283 (94%)	-0.18	5 (1%) 64 64	12, 20, 39, 68	0
1	C	281/283 (99%)	-0.36	2 (0%) 84 86	10, 18, 34, 56	0
All	All	829/849 (97%)	-0.18	12 (1%) 72 73	10, 21, 41, 68	0

All (12) RSRZ outliers are listed below:

Mol	Chain	Res	Type	RSRZ
1	B	320	ASN	4.3
1	B	41	LYS	3.4
1	B	246	TYR	3.2
1	A	41	LYS	3.1
1	A	201	ILE	3.0
1	C	185	ASN	2.8
1	A	278	ASP	2.8
1	B	319	GLU	2.5
1	A	205	GLU	2.3
1	A	319	GLU	2.2
1	C	41	LYS	2.2
1	B	278	ASP	2.2

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

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

### 6.3 Carbohydrates ⓘ

There are no carbohydrates 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. 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, 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	RSR	LLDF	B-factors( $\text{\AA}^2$ )	Q<0.9
2	JA2	C	601	15/15	0.20	3.95	17,25,27,30	0
3	1PG	B	601	17/17	0.22	2.78	32,43,65,66	0
2	JA2	A	601	15/15	0.19	2.66	32,40,44,47	0

## 6.5 Other polymers

There are no such residues in this entry.