



# Full wwPDB X-ray Structure Validation Report ⓘ

May 29, 2020 – 05:45 am BST

PDB ID : 4O6A  
Title : Mouse cyclic GMP-AMP synthase (cGAS) in complex with DNA  
Authors : Zhang, X.; Chen, Z.; Zhang, X.W.; Chen, Z.J.  
Deposited on : 2013-12-20  
Resolution : 1.86 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](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.

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

MolProbity	:	4.02b-467
Xtriage (Phenix)	:	1.13
EDS	:	2.11
Percentile statistics	:	20191225.v01 (using entries in the PDB archive December 25th 2019)
Refmac	:	5.8.0158
CCP4	:	7.0.044 (Gargrove)
Ideal geometry (proteins)	:	Engh & Huber (2001)
Ideal geometry (DNA, RNA)	:	Parkinson et al. (1996)
Validation Pipeline (wwPDB-VP)	:	2.11

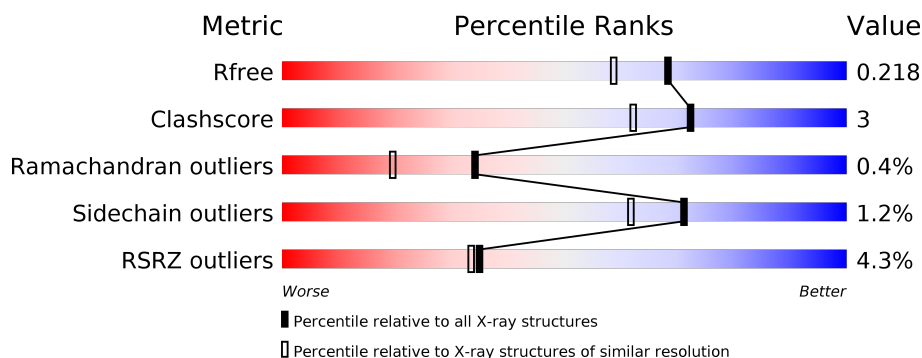
# 1 Overall quality at a glance

The following experimental techniques were used to determine the structure:

*X-RAY DIFFRACTION*

The reported resolution of this entry is 1.86 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))
$R_{free}$	130704	2469 (1.86-1.86)
Clashscore	141614	2625 (1.86-1.86)
Ramachandran outliers	138981	2592 (1.86-1.86)
Sidechain outliers	138945	2592 (1.86-1.86)
RSRZ outliers	127900	2436 (1.86-1.86)

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 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	362	<div> <div>4%</div> <div> <div></div> <div>93%</div> <div>7%</div> <div>.</div> </div> </div>
1	B	362	<div> <div>4%</div> <div> <div></div> <div>90%</div> <div>8%</div> <div>..</div> </div> </div>
2	C	17	<div> <div>12%</div> <div> <div></div> <div>35%</div> <div>47%</div> <div>18%</div> </div> </div>
2	D	17	<div> <div>12%</div> <div> <div></div> <div>47%</div> <div>41%</div> <div>12%</div> </div> </div>
3	E	17	<div> <div></div> <div> <div></div> <div>59%</div> <div>24%</div> <div>18%</div> </div> </div>
3	F	17	<div> <div>6%</div> <div> <div></div> <div>41%</div> <div>59%</div> </div> </div>

## 2 Entry composition

There are 5 unique types of molecules in this entry. The entry contains 8279 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 Cyclic GMP-AMP synthase.

Mol	Chain	Residues	Atoms					ZeroOcc	AltConf	Trace
1	A	361	Total	C	N	O	S	0	0	0
			2984	1918	508	544	14			
1	B	358	Total	C	N	O	S	0	0	0
			2961	1904	505	539	13			

There are 2 discrepancies between the modelled and reference sequences:

Chain	Residue	Modelled	Actual	Comment	Reference
A	146	MET	-	EXPRESSION TAG	UNP Q8C6L5
B	146	MET	-	EXPRESSION TAG	UNP Q8C6L5

- Molecule 2 is a DNA chain called DNA1.

Mol	Chain	Residues	Atoms					ZeroOcc	AltConf	Trace
2	D	15	Total	C	N	O	P	0	0	0
			308	147	63	84	14			
2	C	17	Total	C	N	O	P	0	0	0
			350	167	73	94	16			

- Molecule 3 is a DNA chain called DNA2.

Mol	Chain	Residues	Atoms					ZeroOcc	AltConf	Trace
3	E	14	Total	C	N	O	P	0	0	0
			281	136	47	85	13			
3	F	17	Total	C	N	O	P	0	0	0
			344	166	53	108	17			

- Molecule 4 is ZINC ION (three-letter code: ZN) (formula: Zn).

Mol	Chain	Residues	Atoms		ZeroOcc	AltConf
4	B	1	Total	Zn	0	0
			1	1		

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Mol	Chain	Residues	Atoms		ZeroOcc	AltConf
4	A	1	Total 1	Zn 1	0	0

- Molecule 5 is water.

Mol	Chain	Residues	Atoms		ZeroOcc	AltConf
5	A	429	Total 429	O 429	0	0
5	D	64	Total 64	O 64	0	0
5	E	43	Total 43	O 43	0	0
5	B	369	Total 369	O 369	0	0
5	C	73	Total 73	O 73	0	0
5	F	71	Total 71	O 71	0	0

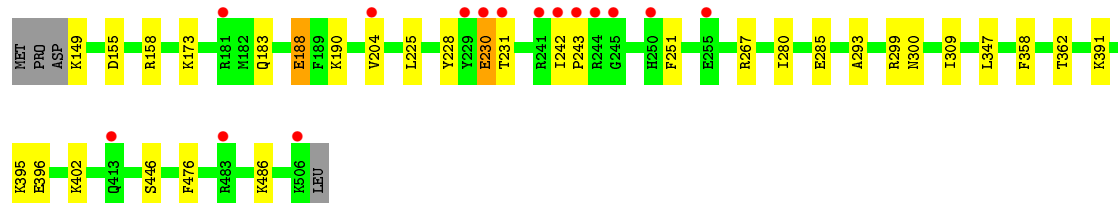
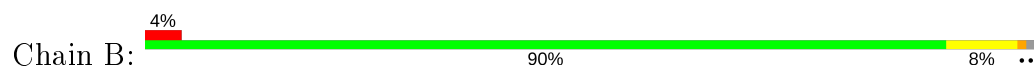
### 3 Residue-property plots [i](#)

These plots are drawn for all protein, RNA and DNA chains in the entry. The first graphic for a chain summarises the proportions of 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.

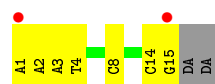
- Molecule 1: Cyclic GMP-AMP synthase



- Molecule 1: Cyclic GMP-AMP synthase



- Molecule 2: DNA1



- Molecule 2: DNA1



- Molecule 3: DNA2





● Molecule 3: DNA2



## 4 Data and refinement statistics

Property	Value	Source
Space group	C 1 2 1	Depositor
Cell constants a, b, c, $\alpha$ , $\beta$ , $\gamma$	183.71Å 96.33Å 75.99Å 90.00° 98.28° 90.00°	Depositor
Resolution (Å)	36.66 – 1.86 36.66 – 1.86	Depositor EDS
% Data completeness (in resolution range)	99.1 (36.66-1.86) 97.3 (36.66-1.86)	Depositor EDS
$R_{merge}$	(Not available)	Depositor
$R_{sym}$	(Not available)	Depositor
$\langle I/\sigma(I) \rangle$ <sup>1</sup>	2.12 (at 1.85Å)	Xtriage
Refinement program	PHENIX (phenix.refine: 1.8.2_1309)	Depositor
R, $R_{free}$	0.186 , 0.218 0.186 , 0.218	Depositor DCC
$R_{free}$ test set	2000 reflections (1.83%)	wwPDB-VP
Wilson B-factor (Å <sup>2</sup> )	26.7	Xtriage
Anisotropy	0.426	Xtriage
Bulk solvent $k_{sol}$ (e/Å <sup>3</sup> ), $B_{sol}$ (Å <sup>2</sup> )	0.31 , 51.0	EDS
L-test for twinning <sup>2</sup>	$\langle  L  \rangle = 0.47$ , $\langle L^2 \rangle = 0.30$	Xtriage
Estimated twinning fraction	No twinning to report.	Xtriage
$F_o, F_c$ correlation	0.95	EDS
Total number of atoms	8279	wwPDB-VP
Average B, all atoms (Å <sup>2</sup> )	37.0	wwPDB-VP

Xtriage's analysis on translational NCS is as follows: *The largest off-origin peak in the Patterson function is 8.04% 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

### 5.1 Standard geometry

Bond lengths and bond angles in the following residue types are not validated in this section: ZN

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	0.37	0/3049	0.52	0/4093
1	B	0.34	0/3025	0.50	0/4060
2	C	0.70	0/395	1.49	7/608 (1.2%)
2	D	0.75	0/347	1.29	1/534 (0.2%)
3	E	0.70	0/313	1.34	4/481 (0.8%)
3	F	0.77	0/382	1.70	7/587 (1.2%)
All	All	0.45	0/7511	0.82	19/10363 (0.2%)

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.

All (19) bond angle outliers are listed below:

Mol	Chain	Res	Type	Atoms	Z	Observed(°)	Ideal(°)
3	F	1	DT	C1'-O4'-C4'	-15.35	94.75	110.10
3	F	1	DT	O4'-C1'-N1	15.33	118.73	108.00
2	C	5	DT	O4'-C1'-N1	-10.61	100.57	108.00
2	C	2	DA	O4'-C1'-N9	-8.90	101.77	108.00
3	E	11	DG	O4'-C1'-N9	-8.39	102.12	108.00
3	F	11	DG	O4'-C1'-N9	-6.86	103.20	108.00
2	C	8	DC	O4'-C1'-N1	6.65	112.65	108.00
3	F	1	DT	C2-N1-C1'	-5.97	108.65	118.20
3	F	1	DT	C6-N1-C1'	5.86	129.19	120.40
3	E	9	DT	N3-C4-O4	5.68	123.31	119.90

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Mol	Chain	Res	Type	Atoms	Z	Observed(°)	Ideal(°)
3	E	12	DG	O4'-C1'-N9	-5.49	104.16	108.00
2	D	8	DC	O4'-C1'-N1	5.46	111.82	108.00
2	C	4	DT	O4'-C1'-N1	-5.45	104.19	108.00
3	F	12	DG	O4'-C1'-N9	-5.34	104.26	108.00
3	E	9	DT	C5-C4-O4	-5.27	121.21	124.90
2	C	17	DA	C3'-C2'-C1'	-5.21	96.24	102.50
2	C	17	DA	O4'-C1'-N9	5.18	111.62	108.00
3	F	1	DT	C5-C6-N1	-5.14	120.62	123.70
2	C	6	DG	O4'-C1'-N9	-5.08	104.44	108.00

There are no chirality outliers.

All (1) planarity outliers are listed below:

Mol	Chain	Res	Type	Group
1	B	228	TYR	Peptide

## 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	2984	0	3031	16	0
1	B	2961	0	3011	15	0
2	C	350	0	191	8	0
2	D	308	0	169	4	0
3	E	281	0	161	1	0
3	F	344	0	196	5	0
4	A	1	0	0	0	0
4	B	1	0	0	0	0
5	A	429	0	0	3	0
5	B	369	0	0	0	0
5	C	73	0	0	0	0
5	D	64	0	0	0	0
5	E	43	0	0	0	0
5	F	71	0	0	0	0
All	All	8279	0	6759	47	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 3.

All (47) 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:173:LYS:HE3	1:B:280:ILE:HD11	1.64	0.79
1:A:177:ARG:HG3	1:A:180:ARG:HH22	1.54	0.72
1:A:358:PHE:O	1:A:362:THR:HG23	1.91	0.71
1:B:267:ARG:NH1	1:B:285:GLU:O	2.24	0.70
1:B:358:PHE:O	1:B:362:THR:HG23	1.93	0.69
1:A:181:ARG:HD2	1:A:185:ARG:HH11	1.59	0.67
1:B:293:ALA:HB2	1:B:309:ILE:HD13	1.82	0.61
2:C:1:DA:H8	2:C:1:DA:HO5'	1.48	0.61
1:A:353:LYS:NZ	5:A:917:HOH:O	2.37	0.58
1:A:173:LYS:HE3	1:A:280:ILE:HD11	1.84	0.58
1:A:242:ILE:HG12	1:A:243:PRO:HA	1.86	0.56
1:B:391:LYS:NZ	1:B:396:GLU:OE1	2.34	0.56
1:B:188:GLU:HG3	1:B:251:PHE:CE2	2.41	0.56
2:C:3:DA:H2''	2:C:4:DT:H72	1.88	0.56
1:A:146:MET:HG3	1:A:149:LYS:H	1.71	0.55
2:D:15:DG:H1	3:E:4:DC:H42	1.53	0.55
2:C:16:DA:H2''	2:C:17:DA:C8	2.42	0.55
3:F:4:DC:H2'	3:F:5:DG:C8	2.42	0.54
2:C:15:DG:C6	2:C:16:DA:C6	2.99	0.50
1:A:146:MET:CG	1:A:149:LYS:H	2.26	0.48
1:B:155:ASP:HA	1:B:158:ARG:NH1	2.29	0.48
2:C:1:DA:H2''	2:C:2:DA:C8	2.50	0.47
1:B:149:LYS:NZ	1:B:446:SER:OG	2.48	0.47
1:A:183:GLN:O	1:A:190:LYS:HG3	2.15	0.46
1:A:451:LYS:HG3	5:A:1002:HOH:O	2.16	0.45
1:A:156:LYS:NZ	5:A:837:HOH:O	2.48	0.45
1:B:476:PHE:HB3	1:B:486:LYS:HE2	1.97	0.45
1:B:183:GLN:O	1:B:190:LYS:HG3	2.17	0.45
3:F:8:DT:H2''	3:F:9:DT:H5'	1.98	0.45
2:C:16:DA:C5	2:C:17:DA:C6	3.06	0.44
1:A:248:LEU:HA	1:A:251:PHE:CD2	2.53	0.44
1:B:230:GLU:HG2	1:B:231:THR:N	2.33	0.44
2:D:3:DA:H2''	2:D:4:DT:H72	2.00	0.44
1:A:189:PHE:O	1:A:192:VAL:HG22	2.18	0.43
2:C:16:DA:C5	2:C:17:DA:N1	2.87	0.43
1:B:225:LEU:HD21	1:B:347:LEU:HD11	2.01	0.43
1:B:204:VAL:O	1:B:402:LYS:NZ	2.49	0.43
2:D:14:DC:H2''	2:D:15:DG:C8	2.54	0.42

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Atom-1	Atom-2	Interatomic distance (Å)	Clash overlap (Å)
1:B:395:LYS:NZ	2:C:11:DA:OP1	2.46	0.42
1:B:188:GLU:HG3	1:B:251:PHE:HE2	1.83	0.42
1:A:196:ASN:HB3	1:A:201:TYR:CD2	2.55	0.41
1:A:353:LYS:HA	1:A:353:LYS:HD3	1.74	0.41
1:A:177:ARG:HA	1:A:180:ARG:NH2	2.36	0.41
3:F:8:DT:H2'	3:F:9:DT:C6	2.56	0.41
3:F:2:DT:H1'	3:F:3:DT:H5'	2.02	0.41
2:D:1:DA:H2''	2:D:2:DA:C8	2.56	0.41
3:F:5:DG:H2'	3:F:6:DT:H71	2.03	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	359/362 (99%)	348 (97%)	10 (3%)	1 (0%)	41	26
1	B	356/362 (98%)	348 (98%)	6 (2%)	2 (1%)	25	12
All	All	715/724 (99%)	696 (97%)	16 (2%)	3 (0%)	34	19

All (3) Ramachandran outliers are listed below:

Mol	Chain	Res	Type
1	B	243	PRO
1	A	300	ASN
1	B	300	ASN

### 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	334/335 (100%)	330 (99%)	4 (1%)	71	62
1	B	331/335 (99%)	327 (99%)	4 (1%)	71	62
All	All	665/670 (99%)	657 (99%)	8 (1%)	71	62

All (8) residues with a non-rotameric sidechain are listed below:

Mol	Chain	Res	Type
1	A	241	ARG
1	A	242	ILE
1	A	250	HIS
1	A	353	LYS
1	B	188	GLU
1	B	230	GLU
1	B	242	ILE
1	B	299	ARG

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

### 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 carbohydrates in this entry.

## 5.6 Ligand geometry ⓘ

Of 2 ligands modelled in this entry, 2 are monoatomic - leaving 0 for Mogul analysis.

There are no bond length outliers.

There are no bond angle outliers.

There are no chirality outliers.

There are no torsion outliers.

There are no ring outliers.

No monomer is involved in short contacts.

## 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	361/362 (99%)	0.01	14 (3%) 39 38	16, 26, 59, 134	0
1	B	358/362 (98%)	0.12	15 (4%) 36 34	17, 32, 72, 141	0
2	C	17/17 (100%)	-0.02	2 (11%) 4 4	20, 27, 103, 125	0
2	D	15/17 (88%)	0.05	2 (13%) 3 3	22, 33, 85, 96	0
3	E	14/17 (82%)	0.06	0 100 100	24, 38, 76, 91	0
3	F	17/17 (100%)	0.34	1 (5%) 22 22	21, 33, 118, 137	0
All	All	782/792 (98%)	0.07	34 (4%) 35 33	16, 29, 73, 141	0

All (34) RSRZ outliers are listed below:

Mol	Chain	Res	Type	RSRZ
1	B	244	ARG	8.4
1	A	242	ILE	8.4
1	A	243	PRO	6.9
1	B	243	PRO	6.6
1	B	245	GLY	5.7
1	B	229	TYR	5.7
1	B	242	ILE	5.4
1	A	241	ARG	5.1
3	F	1	DT	5.1
1	A	245	GLY	4.9
1	A	244	ARG	4.2
2	C	17	DA	3.9
1	B	241	ARG	3.8
2	D	15	DG	3.6
1	B	413	GLN	3.3
1	A	229	TYR	3.3
1	B	255	GLU	3.1
1	A	186	GLU	3.1
1	B	231	THR	2.9

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Mol	Chain	Res	Type	RSRZ
1	A	185	ARG	2.9
1	B	181	ARG	2.8
1	A	255	GLU	2.8
1	A	184	LYS	2.8
1	B	483	ARG	2.8
1	B	230	GLU	2.7
1	A	246	ASN	2.6
1	B	250	HIS	2.5
1	A	413	GLN	2.5
2	C	16	DA	2.3
2	D	1	DA	2.3
1	B	506	LYS	2.2
1	A	247	PRO	2.2
1	B	204	VAL	2.1
1	A	181	ARG	2.0

## 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. 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
4	ZN	A	601	1/1	0.99	0.09	21,21,21,21	0
4	ZN	B	601	1/1	0.99	0.10	25,25,25,25	0

## 6.5 Other polymers [i](#)

There are no such residues in this entry.