



# Full wwPDB X-ray Structure Validation Report ⓘ

Jul 1, 2025 – 04:06 PM EDT

PDB ID : 9NJH / pdb\_00009njh  
Title : Translocated product complex of DNA polymerase iota with DNA (template A)  
Authors : Frevert, Z.; Freudenthal, B.; Washington, M.T.  
Deposited on : 2025-02-27  
Resolution : 2.29 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.

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 Phenix2.0rc1  
Xtriage (Phenix) : 2.0rc1  
EDS : 3.0  
Percentile statistics : 20231227.v01 (using entries in the PDB archive December 27th 2023)  
CCP4 : 9.0.006 (Gargrove)  
Density-Fitness : 1.0.12  
Ideal geometry (proteins) : Engh & Huber (2001)  
Ideal geometry (DNA, RNA) : Parkinson et al. (1996)  
Validation Pipeline (wwPDB-VP) : 2.44

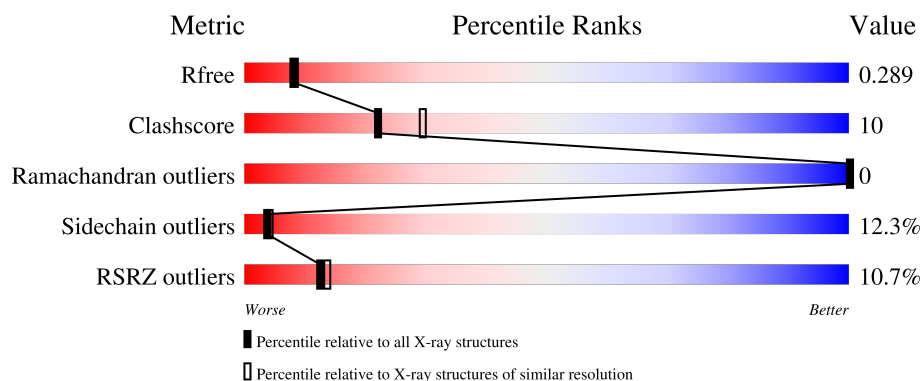
# 1 Overall quality at a glance

The following experimental techniques were used to determine the structure:

*X-RAY DIFFRACTION*

The reported resolution of this entry is 2.29 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	5963 (2.30-2.30)
Clashscore	180529	6698 (2.30-2.30)
Ramachandran outliers	177936	6640 (2.30-2.30)
Sidechain outliers	177891	6640 (2.30-2.30)
RSRZ outliers	164620	5963 (2.30-2.30)

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	420	<div> <div>10%</div> <div>59%</div> <div>25%</div> <div>•</div> <div>13%</div> </div>
2	B	17	<div> <div>6%</div> <div>47%</div> <div>41%</div> <div>12%</div> </div>

## 2 Entry composition

There are 4 unique types of molecules in this entry. The entry contains 3298 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 DNA polymerase iota.

Mol	Chain	Residues	Atoms					ZeroOcc	AltConf	Trace
1	A	367	Total	C	N	O	S	0	0	0
			2892	1825	504	542	21			

- Molecule 2 is a DNA chain called DNA (5'-D(P\*AP\*GP\*GP\*GP\*TP\*CP\*CP\*TP\*AP\*GP\*GP\*AP\*CP\*CP\*C)-3').

Mol	Chain	Residues	Atoms					ZeroOcc	AltConf	Trace
2	B	15	Total	C	N	O	P	0	1	0
			329	155	64	94	16			

- Molecule 3 is CALCIUM ION (CCD ID: CA) (formula: Ca).

Mol	Chain	Residues	Atoms		ZeroOcc	AltConf
3	A	1	Total	Ca	0	0
			1	1		

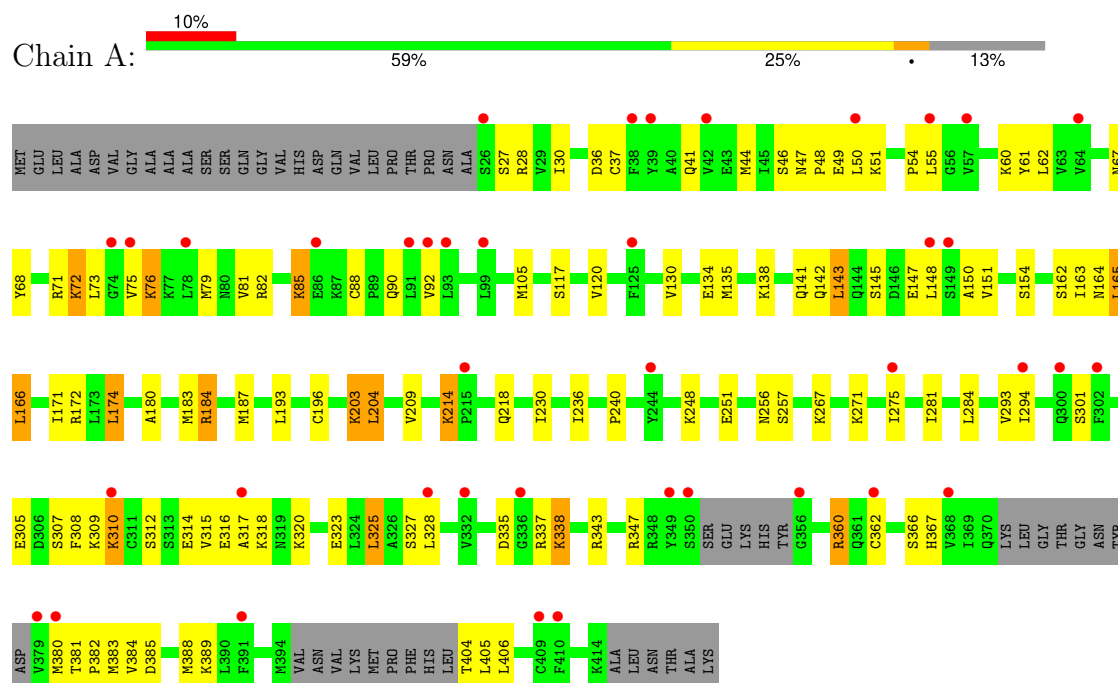
- Molecule 4 is water.

Mol	Chain	Residues	Atoms		ZeroOcc	AltConf
4	A	68	Total	O	0	0
			68	68		
4	B	8	Total	O	0	0
			8	8		

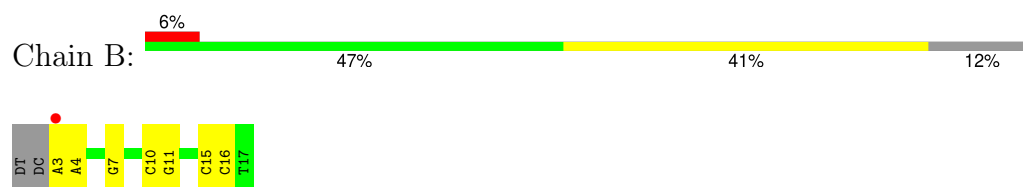
### 3 Residue-property plots [i](#)

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: DNA polymerase iota



- Molecule 2: DNA (5'-D(P\*AP\*GP\*GP\*GP\*TP\*CP\*CP\*TP\*AP\*GP\*GP\*AP\*CP\*CP\*C)-3')



## 4 Data and refinement statistics

Property	Value	Source
Space group	P 65 2 2	Depositor
Cell constants a, b, c, $\alpha$ , $\beta$ , $\gamma$	97.93Å 97.93Å 194.97Å 90.00° 90.00° 120.00°	Depositor
Resolution (Å)	48.96 – 2.29 48.96 – 2.29	Depositor EDS
% Data completeness (in resolution range)	100.0 (48.96-2.29) 99.9 (48.96-2.29)	Depositor EDS
$R_{merge}$	(Not available)	Depositor
$R_{sym}$	(Not available)	Depositor
$\langle I/\sigma(I) \rangle$ <sup>1</sup>	1.60 (at 2.29Å)	Xtriage
Refinement program	PHENIX 1.20.1_4487	Depositor
R, $R_{free}$	0.264 , 0.288 0.264 , 0.289	Depositor DCC
$R_{free}$ test set	1286 reflections (5.01%)	wwPDB-VP
Wilson B-factor (Å <sup>2</sup> )	53.3	Xtriage
Anisotropy	0.238	Xtriage
Bulk solvent $k_{sol}$ (e/Å <sup>3</sup> ), $B_{sol}$ (Å <sup>2</sup> )	0.30 , 40.0	EDS
L-test for twinning <sup>2</sup>	$\langle  L  \rangle = 0.49$ , $\langle L^2 \rangle = 0.32$	Xtriage
Estimated twinning fraction	No twinning to report.	Xtriage
$F_o, F_c$ correlation	0.93	EDS
Total number of atoms	3298	wwPDB-VP
Average B, all atoms (Å <sup>2</sup> )	65.0	wwPDB-VP

Xtriage's analysis on translational NCS is as follows: *The largest off-origin peak in the Patterson function is 3.78% 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: CA

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	0.87	0/2931	1.22	0/3948
2	B	0.49	0/369	0.79	0/567
All	All	0.83	0/3300	1.18	0/4515

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	3

There are no bond length outliers.

There are no bond angle outliers.

There are no chirality outliers.

All (3) planarity outliers are listed below:

Mol	Chain	Res	Type	Group
1	A	184	ARG	Sidechain
1	A	28	ARG	Sidechain
1	A	343	ARG	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	2892	0	2980	63	1
2	B	329	0	179	4	1
3	A	1	0	0	0	0
4	A	68	0	0	1	0
4	B	8	0	0	0	0
All	All	3298	0	3159	67	1

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 10.

All (67) 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:325:LEU:HD11	1:A:383:MET:HB3	1.60	0.82
1:A:314:GLU:HG3	1:A:316:GLU:H	1.52	0.73
1:A:347:ARG:HB2	1:A:405:LEU:HB3	1.73	0.70
1:A:314:GLU:HB3	1:A:316:GLU:HG2	1.77	0.67
1:A:305:GLU:HB2	1:A:405:LEU:HD21	1.76	0.66
1:A:318:LYS:HE2	1:A:384:VAL:HG11	1.81	0.62
1:A:163:ILE:HG21	1:A:174:LEU:HD11	1.82	0.61
1:A:180:ALA:HA	1:A:183:MET:HE2	1.81	0.61
1:A:148:LEU:O	1:A:151:VAL:HG22	2.02	0.60
1:A:47:ASN:HB3	1:A:50:LEU:HG	1.83	0.59
1:A:196:CYS:SG	1:A:214:LYS:O	2.61	0.59
1:A:88:CYS:SG	1:A:90:GLN:HG2	2.44	0.57
1:A:347:ARG:CB	1:A:405:LEU:HB3	2.34	0.57
1:A:50:LEU:HD22	1:A:92:VAL:HG21	1.87	0.55
1:A:184:ARG:HA	1:A:187:MET:HE2	1.88	0.55
1:A:138:LYS:O	1:A:141:GLN:HG3	2.07	0.54
1:A:90:GLN:HB3	4:A:667:HOH:O	2.07	0.54
2:B:10:DC:H2''	2:B:11:DG:C8	2.44	0.53
1:A:267:LYS:O	1:A:271:LYS:HG2	2.09	0.52
1:A:335:ASP:OD2	1:A:337:ARG:HB2	2.09	0.52
1:A:309:LYS:O	1:A:310:LYS:C	2.53	0.51
1:A:385:ASP:O	1:A:389:LYS:HG3	2.12	0.50
1:A:204:LEU:HD12	1:A:240:PRO:HD2	1.94	0.50
2:B:3[B]:DA:H2''	2:B:4:DA:C8	2.47	0.50
1:A:82:ARG:HA	1:A:85:LYS:HG3	1.94	0.49
1:A:36:ASP:O	1:A:37:CYS:C	2.54	0.49
1:A:76:LYS:HB2	1:A:79:MET:HE3	1.94	0.48
1:A:54:PRO:HG2	1:A:90:GLN:HG3	1.96	0.47
1:A:30:ILE:HG21	1:A:203:LYS:HG2	1.96	0.46

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Atom-1	Atom-2	Interatomic distance (Å)	Clash overlap (Å)
1:A:165:LEU:HD12	1:A:171:ILE:HD13	1.97	0.46
1:A:61:TYR:CE2	1:A:62:LEU:HG	2.51	0.46
1:A:48:PRO:O	1:A:49:GLU:C	2.59	0.45
1:A:120:VAL:HG22	1:A:130:VAL:HG22	1.97	0.45
1:A:381:THR:N	1:A:382:PRO:HD2	2.32	0.45
1:A:141:GLN:NE2	1:A:142:GLN:HG2	2.32	0.44
2:B:4:DA:OP2	2:B:4:DA:H2'	2.17	0.44
1:A:203:LYS:HD3	1:A:293:VAL:HG22	1.98	0.44
1:A:60:LYS:HB3	1:A:61:TYR:H	1.60	0.44
2:B:15:DC:H2'	2:B:16:DC:C6	2.53	0.44
1:A:41:GLN:HG2	1:A:193:LEU:HD23	1.99	0.44
1:A:154:SER:O	1:A:218:GLN:NE2	2.51	0.44
1:A:27:SER:HB3	1:A:172:ARG:HH12	1.82	0.44
1:A:44:MET:HE3	1:A:51:LYS:HA	1.99	0.43
1:A:314:GLU:C	1:A:316:GLU:N	2.76	0.43
1:A:315:VAL:C	1:A:317:ALA:N	2.75	0.43
1:A:44:MET:HG3	1:A:55:LEU:HD23	2.01	0.43
1:A:27:SER:O	1:A:172:ARG:NH2	2.51	0.42
1:A:204:LEU:CD1	1:A:240:PRO:HD2	2.49	0.42
1:A:338:LYS:HD3	1:A:338:LYS:HA	1.72	0.42
1:A:148:LEU:C	1:A:150:ALA:H	2.27	0.42
1:A:55:LEU:H	1:A:67:ASN:CG	2.27	0.42
1:A:72:LYS:HE2	1:A:72:LYS:HB3	1.48	0.42
1:A:68:TYR:HA	1:A:71:ARG:HD2	2.01	0.42
1:A:117:SER:HB2	1:A:135:MET:CE	2.49	0.42
1:A:134:GLU:O	1:A:138:LYS:HD3	2.19	0.42
1:A:164:ASN:C	1:A:166:LEU:H	2.27	0.42
1:A:71:ARG:HA	1:A:75:VAL:O	2.19	0.42
1:A:406:LEU:HD23	1:A:406:LEU:HA	1.90	0.42
1:A:360:ARG:HD3	1:A:360:ARG:HA	1.95	0.41
1:A:47:ASN:O	1:A:48:PRO:C	2.62	0.41
1:A:117:SER:HB2	1:A:135:MET:HE2	2.03	0.41
1:A:105:MET:CG	1:A:193:LEU:HD11	2.51	0.41
1:A:281:ILE:HA	1:A:284:LEU:HD12	2.03	0.40
1:A:328:LEU:HD12	1:A:328:LEU:HA	1.84	0.40
1:A:316:GLU:C	1:A:318:LYS:N	2.78	0.40
1:A:347:ARG:CZ	1:A:405:LEU:HB2	2.52	0.40
1:A:143:LEU:HD23	1:A:143:LEU:HA	1.77	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	Interatomic distance (Å)	Clash overlap (Å)
1:A:301:SER:OG	2:B:7:DG:OP2[10_665]	1.83	0.37

## 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	359/420 (86%)	344 (96%)	15 (4%)	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	334/376 (89%)	293 (88%)	41 (12%)	4	4

All (41) residues with a non-rotameric sidechain are listed below:

Mol	Chain	Res	Type
1	A	46	SER
1	A	72	LYS
1	A	73	LEU
1	A	76	LYS
1	A	81	VAL
1	A	85	LYS
1	A	143	LEU
1	A	145	SER

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Mol	Chain	Res	Type
1	A	147	GLU
1	A	162	SER
1	A	165	LEU
1	A	166	LEU
1	A	174	LEU
1	A	203	LYS
1	A	204	LEU
1	A	209	VAL
1	A	214	LYS
1	A	230	ILE
1	A	236	ILE
1	A	248	LYS
1	A	251	GLU
1	A	256	ASN
1	A	257	SER
1	A	275	ILE
1	A	294	ILE
1	A	307	SER
1	A	308	PHE
1	A	310	LYS
1	A	312	SER
1	A	320	LYS
1	A	323	GLU
1	A	325	LEU
1	A	327	SER
1	A	338	LYS
1	A	360	ARG
1	A	362	CYS
1	A	366	SER
1	A	367	HIS
1	A	380	MET
1	A	388	MET
1	A	404	THR

Sometimes sidechains can be flipped to improve hydrogen bonding and reduce clashes. All (3) such sidechains are listed below:

Mol	Chain	Res	Type
1	A	128	ASN
1	A	256	ASN
1	A	370	GLN

### 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](#)

Of 1 ligands modelled in this entry, 1 is 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 [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<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	367/420 (87%)	0.74	40 (10%) 12 13	39, 64, 97, 122	0
2	B	15/17 (88%)	-0.25	1 (6%) 25 27	37, 57, 64, 69	1 (6%)
All	All	382/437 (87%)	0.70	41 (10%) 12 14	37, 64, 97, 122	1 (0%)

All (41) RSRZ outliers are listed below:

Mol	Chain	Res	Type	RSRZ
1	A	91	LEU	10.0
1	A	55	LEU	4.8
1	A	410	PHE	4.7
1	A	50	LEU	4.6
1	A	332	VAL	4.2
1	A	93	LEU	3.7
1	A	75	VAL	3.7
1	A	368	VAL	3.6
1	A	42	VAL	3.4
1	A	125	PHE	3.3
1	A	310	LYS	3.3
1	A	148	LEU	3.2
1	A	391	PHE	3.2
1	A	328	LEU	3.0
1	A	244	TYR	3.0
1	A	317	ALA	3.0
1	A	362	CYS	2.8
1	A	39	TYR	2.8
1	A	350	SER	2.7
1	A	356	GLY	2.7
1	A	38	PHE	2.7
1	A	336	GLY	2.7
1	A	349	TYR	2.7
1	A	57	VAL	2.6

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Mol	Chain	Res	Type	RSRZ
1	A	149	SER	2.6
1	A	302	PHE	2.6
1	A	26	SER	2.6
1	A	215	PRO	2.6
1	A	92	VAL	2.5
1	A	86	GLU	2.5
1	A	294	ILE	2.4
1	A	275	ILE	2.4
1	A	300	GLN	2.4
1	A	379	VAL	2.4
2	B	3[A]	DA	2.3
1	A	74	GLY	2.2
1	A	78	LEU	2.2
1	A	99	LEU	2.2
1	A	409	CYS	2.1
1	A	64	VAL	2.1
1	A	380	MET	2.0

## 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 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, 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(Å <sup>2</sup> )	Q<0.9
3	CA	A	501	1/1	0.95	0.23	82,82,82,82	0

## 6.5 Other polymers ⓘ

There are no such residues in this entry.