



# Full wwPDB X-ray Structure Validation Report

Feb 28, 2014 – 02:09 PM GMT

PDB ID : 4JS5  
Title : Crystal structure of E. coli Exonuclease I in complex with a dT13 oligonucleotide  
Authors : Bell, C.E.  
Deposited on : 2013-03-22  
Resolution : 3.50 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>

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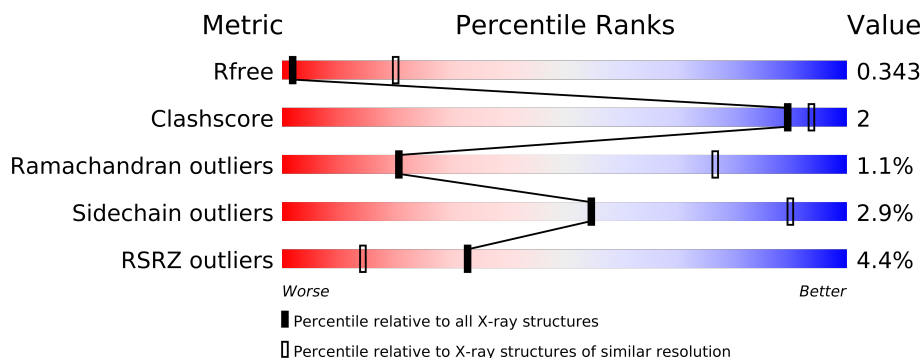
The following versions of software and data (see [references](#)) were used in the production of this report:

MolProbity : 4.02b-467  
Mogul : 1.15 2013  
Xtriage (Phenix) : dev-1323  
EDS : stable22639  
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) : stable22683

# 1 Overall quality at a glance

The reported resolution of this entry is 3.50 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	1243 (3.70-3.30)
Clashscore	79885	1039 (3.66-3.34)
Ramachandran outliers	78287	1000 (3.66-3.34)
Sidechain outliers	78261	1000 (3.66-3.34)
RSRZ outliers	66119	1243 (3.70-3.30)

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 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	C	13	
1	D	13	
2	A	478	
2	B	478	

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

Mol	Type	Chain	Res	Geometry	Electron density
3	SO4	A	501	-	X
3	SO4	B	501	-	X

## 2 Entry composition

There are 3 unique types of molecules in this entry. The entry contains 7861 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 DNA chain called dT13 oligonucleotide.

Mol	Chain	Residues	Atoms					ZeroOcc	AltConf	Trace
1	C	11	Total	C	N	O	P	0	0	0
			220	110	22	77	11			
1	D	10	Total	C	N	O	P	0	0	0
			200	100	20	70	10			

- Molecule 2 is a protein called Exodeoxyribonuclease I.

Mol	Chain	Residues	Atoms					ZeroOcc	AltConf	Trace
2	A	464	Total	C	N	O	S	0	0	0
			3716	2371	649	682	14			
2	B	464	Total	C	N	O	S	0	0	0
			3715	2370	648	683	14			

There are 6 discrepancies between the modelled and reference sequences:

Chain	Residue	Modelled	Actual	Comment	Reference
A	-2	GLY	-	EXPRESSION TAG	UNP P04995
A	-1	SER	-	EXPRESSION TAG	UNP P04995
A	0	HIS	-	EXPRESSION TAG	UNP P04995
B	-2	GLY	-	EXPRESSION TAG	UNP P04995
B	-1	SER	-	EXPRESSION TAG	UNP P04995
B	0	HIS	-	EXPRESSION TAG	UNP P04995

- Molecule 3 is SULFATE ION (three-letter code: SO4) (formula: O<sub>4</sub>S).



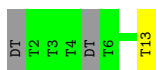
Mol	Chain	Residues	Atoms			ZeroOcc	AltConf
3	A	1	Total	O	S	0	0
			5	4	1		
3	B	1	Total	O	S	0	0
			5	4	1		

### 3 Residue-property plots

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.

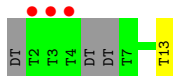
- Molecule 1: dT13 oligonucleotide

Chain C: 



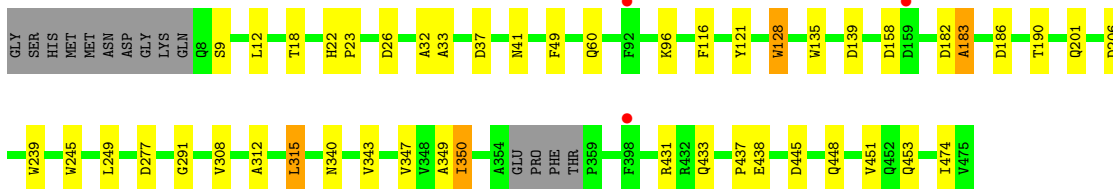
- Molecule 1: dT13 oligonucleotide

Chain D: 



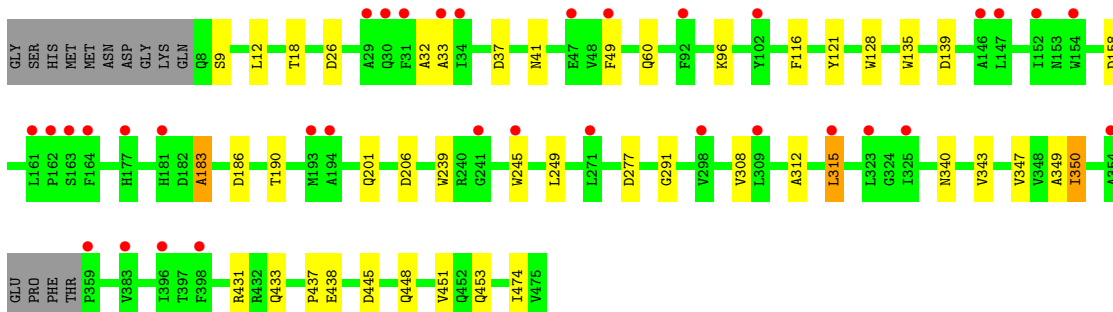
- Molecule 2: Exodeoxyribonuclease I

Chain A: 



- Molecule 2: Exodeoxyribonuclease I

Chain B: 



## 4 Data and refinement statistics

Property	Value	Source
Space group	P 31 2 1	Depositor
Cell constants a, b, c, $\alpha$ , $\beta$ , $\gamma$	158.33Å 158.33Å 151.05Å 90.00° 90.00° 120.00°	Depositor
Resolution (Å)	49.00 – 3.50 49.02 – 3.50	Depositor EDS
% Data completeness (in resolution range)	99.9 (49.00-3.50) 99.9 (49.02-3.50)	Depositor EDS
$R_{merge}$	0.10	Depositor
$R_{sym}$	(Not available)	Depositor
$\langle I/\sigma(I) \rangle$ <sup>1</sup>	1.94 (at 3.48Å)	Xtriage
Refinement program	REFMAC 5.7.0029	Depositor
R, $R_{free}$	0.306 , 0.346 0.305 , 0.343	Depositor DCC
$R_{free}$ test set	1406 reflections (5.28%)	DCC
Wilson B-factor (Å <sup>2</sup> )	137.3	Xtriage
Anisotropy	0.025	Xtriage
Bulk solvent $k_{sol}$ (e/Å <sup>3</sup> ), $B_{sol}$ (Å <sup>2</sup> )	0.31 , 159.4	EDS
Estimated twinning fraction	0.058 for -h,-k,l	Xtriage
L-test for twinning	$\langle  L  \rangle = 0.44$ , $\langle L^2 \rangle = 0.27$	Xtriage
Outliers	6 of 28011 reflections (0.021%)	Xtriage
$F_o, F_c$ correlation	0.92	EDS
Total number of atoms	7861	wwPDB-VP
Average B, all atoms (Å <sup>2</sup> )	199.0	wwPDB-VP

Xtriage's analysis on translational NCS is as follows: *The largest off-origin peak in the Patterson function is 4.48% of the height of the origin peak. No significant pseudotranslation is detected.*

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

## 5 Model quality

### 5.1 Standard geometry

Bond lengths and bond angles in the following residue types are not validated in this section: SO4

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	C	0.33	0/240	0.79	0/366
1	D	0.30	0/218	0.73	0/332
2	A	0.29	0/3813	0.48	0/5194
2	B	0.28	0/3812	0.48	0/5194
All	All	0.29	0/8083	0.50	0/11086

There are no bond length outliers.

There are no bond angle outliers.

There are no chirality outliers.

There are no planarity outliers.

### 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	C	220	0	134	1	0
1	D	200	0	122	1	0
2	A	3716	0	3565	18	7
2	B	3715	0	3558	15	7
3	A	5	0	0	0	0
3	B	5	0	0	0	0
All	All	7861	0	7379	33	7

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 2.

All (33) close contacts within the same asymmetric unit are listed below.

Atom-1	Atom-2	Distance(Å)	Clash(Å)
1:C:13:DT:O3'	2:A:18:THR:N	2.39	0.55
1:D:13:DT:O3'	2:B:18:THR:N	2.40	0.53
2:A:186:ASP:O	2:A:190:THR:N	2.43	0.50
2:B:32:ALA:HB2	2:B:183:ALA:HB1	1.94	0.49
2:B:186:ASP:O	2:B:190:THR:N	2.42	0.48
2:A:32:ALA:HB2	2:A:183:ALA:HB1	1.95	0.48
2:B:431:ARG:NH2	2:B:474:ILE:O	2.47	0.48
2:A:245:TRP:CH2	2:A:315:LEU:HD13	2.49	0.48
2:A:431:ARG:NH2	2:A:474:ILE:O	2.46	0.48
2:A:249:LEU:HD12	2:A:347:VAL:HG11	1.98	0.46
2:B:249:LEU:HD12	2:B:347:VAL:HG11	1.97	0.45
2:B:245:TRP:CH2	2:B:315:LEU:HD13	2.51	0.45
2:A:37:ASP:OD2	2:A:41:ASN:N	2.45	0.45
2:B:116:PHE:HB3	2:B:121:TYR:HB2	1.98	0.45
2:A:116:PHE:HB3	2:A:121:TYR:HB2	1.99	0.45
2:A:26:ASP:OD1	2:A:60:GLN:NE2	2.50	0.44
2:B:26:ASP:OD1	2:B:60:GLN:NE2	2.49	0.44
2:B:37:ASP:OD2	2:B:41:ASN:N	2.46	0.44
2:A:340:ASN:HB3	2:A:343:VAL:HG23	2.02	0.42
2:B:139:ASP:HB3	2:B:308:VAL:HG23	2.01	0.42
2:A:448:GLN:O	2:A:451:VAL:HG12	2.20	0.41
2:B:9:SER:HA	2:B:96:LYS:HB3	2.02	0.41
2:A:22:HIS:HA	2:A:23:PRO:HD3	1.96	0.41
2:A:12:LEU:HD11	2:A:33:ALA:HB1	2.02	0.41
2:A:9:SER:HA	2:A:96:LYS:HB3	2.01	0.41
2:A:349:ALA:O	2:A:350:ILE:C	2.58	0.41
2:B:349:ALA:O	2:B:350:ILE:C	2.59	0.41
2:B:340:ASN:HB3	2:B:343:VAL:HG23	2.02	0.41
2:B:448:GLN:O	2:B:451:VAL:HG12	2.21	0.40
2:A:182:ASP:O	2:A:183:ALA:C	2.59	0.40
2:B:12:LEU:HD11	2:B:33:ALA:HB1	2.03	0.40
2:A:139:ASP:HB3	2:A:308:VAL:HG23	2.02	0.40
2:A:128:TRP:C	2:A:128:TRP:CD1	2.95	0.40

All (7) 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)
2:A:453:GLN:OE1	2:B:453:GLN:NE2[4_656]	1.04	1.16

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Atom-1	Atom-2	Distance(Å)	Clash(Å)
2:A:453:GLN:OE1	2:B:453:GLN:CD[4_656]	1.72	0.48
2:A:433:GLN:OE1	2:B:433:GLN:OE1[4_656]	1.78	0.42
2:A:453:GLN:CD	2:B:453:GLN:OE1[4_656]	1.86	0.34
2:A:453:GLN:NE2	2:B:453:GLN:OE1[4_656]	1.91	0.29
2:A:453:GLN:OE1	2:B:453:GLN:OE1[4_656]	2.09	0.11
2:A:453:GLN:CD	2:B:453:GLN:NE2[4_656]	2.15	0.05

## 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	
2	A	460/478 (96%)	420 (91%)	35 (8%)	5 (1%)	21	77
2	B	460/478 (96%)	418 (91%)	37 (8%)	5 (1%)	21	77
All	All	920/956 (96%)	838 (91%)	72 (8%)	10 (1%)	21	77

All (10) Ramachandran outliers are listed below:

Mol	Chain	Res	Type
2	A	312	ALA
2	B	312	ALA
2	A	291	GLY
2	B	291	GLY
2	A	183	ALA
2	B	183	ALA
2	A	437	PRO
2	B	437	PRO
2	A	350	ILE
2	B	350	ILE

### 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	
2	A	383/409 (94%)	372 (97%)	11 (3%)	55	90
2	B	382/409 (93%)	371 (97%)	11 (3%)	55	90
All	All	765/818 (94%)	743 (97%)	22 (3%)	55	90

All (22) residues with a non-rotameric sidechain are listed below:

Mol	Chain	Res	Type
2	A	49	PHE
2	A	128	TRP
2	A	135	TRP
2	A	158	ASP
2	A	201	GLN
2	A	206	ASP
2	A	239	TRP
2	A	277	ASP
2	A	315	LEU
2	A	438	GLU
2	A	445	ASP
2	B	49	PHE
2	B	128	TRP
2	B	135	TRP
2	B	158	ASP
2	B	201	GLN
2	B	206	ASP
2	B	239	TRP
2	B	277	ASP
2	B	315	LEU
2	B	438	GLU
2	B	445	ASP

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

Mol	Chain	Res	Type
2	A	60	GLN
2	A	242	ASN
2	B	60	GLN
2	B	242	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 ⓘ

2 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	$\# Z  > 2$
3	SO4	A	501	-	4,4,4	0.43	0	6,6,6	0.06	0
3	SO4	B	501	-	4,4,4	0.41	0	6,6,6	0.13	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
3	SO4	A	501	-	-	0/0/0/0	0/0/0/0
3	SO4	B	501	-	-	0/0/0/0	0/0/0/0

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.

## 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	C	11/13 (84%)	0.32	0 100 100	146, 174, 196, 251	0
1	D	10/13 (76%)	0.67	3 (30%) 1 1	174, 208, 222, 231	0
2	A	464/478 (97%)	0.29	3 (0%) 86 59	114, 178, 222, 256	29 (6%)
2	B	464/478 (97%)	0.60	34 (7%) 15 7	147, 220, 277, 311	29 (6%)
All	All	949/982 (96%)	0.45	40 (4%) 33 14	114, 197, 262, 311	58 (6%)

All (40) RSRZ outliers are listed below:

Mol	Chain	Res	Type	RSRZ
2	B	34	ILE	5.4
2	B	164	PHE	5.3
2	B	33	ALA	5.3
2	B	354	ALA	4.5
2	B	162	PRO	4.2
2	B	325	ILE	3.8
2	B	315	LEU	3.6
2	B	193	MET	3.3
2	B	271	LEU	3.1
2	B	102	TYR	3.1
2	B	152	ILE	3.0
2	B	30	GLN	3.0
2	B	359	PRO	3.0
1	D	4	DT	2.9
2	B	309	LEU	2.9
2	B	154	TRP	2.9
2	B	147	LEU	2.7
2	B	245	TRP	2.7
2	B	181	HIS	2.7
2	B	194	ALA	2.6
2	B	47	GLU	2.6

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Mol	Chain	Res	Type	RSRZ
2	B	146	ALA	2.5
1	D	2	DT	2.5
2	B	161	LEU	2.5
2	B	92	PHE	2.5
2	B	177	HIS	2.4
1	D	3	DT	2.4
2	B	163	SER	2.3
2	B	49	PHE	2.3
2	B	398	PHE	2.3
2	B	298	VAL	2.2
2	B	241	GLY	2.2
2	A	398	PHE	2.1
2	B	383	VAL	2.1
2	A	92	PHE	2.1
2	B	29	ALA	2.1
2	B	31	PHE	2.1
2	B	323	LEU	2.0
2	A	159	ASP	2.0
2	B	396	ILE	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 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(Å <sup>2</sup> )	Q<0.9
3	SO4	A	501	5/5	0.81	7.73	197,200,203,206	0
3	SO4	B	501	5/5	0.69	4.07	225,229,232,234	0

## 6.5 Other polymers ⓘ

There are no such residues in this entry.