



# wwPDB X-ray Structure Validation Summary Report

Feb 28, 2014 – 08:27 AM GMT

PDB ID : 1RF2  
Title : Cholera Toxin B-Pentamer Complexed With Bivalent Nitrophenol-Galactoside Ligand BV4  
Authors : Pickens, J.C.; Mitchell, D.D.; Liu, J.; Tan, X.; Zhang, Z.; Verlinde, C.L.; Hol, W.G.; Fan, E.  
Deposited on : 2003-11-07  
Resolution : 1.35 Å(reported)

This is a wwPDB validation summary 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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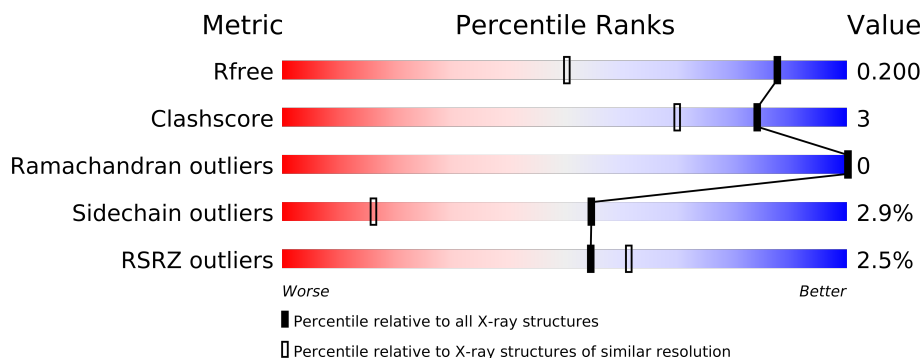
The following versions of software and data (see [references](#)) were used in the production of this report:

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 1.35 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	1519 (1.40-1.32)
Clashscore	79885	1707 (1.40-1.32)
Ramachandran outliers	78287	1662 (1.40-1.32)
Sidechain outliers	78261	1661 (1.40-1.32)
RSRZ outliers	66119	1519 (1.40-1.32)

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	D	103	
1	E	103	
1	F	103	
1	G	103	
1	H	103	

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	BV4	G	107	-	X
2	BV4	H	108	-	X

## 2 Entry composition i

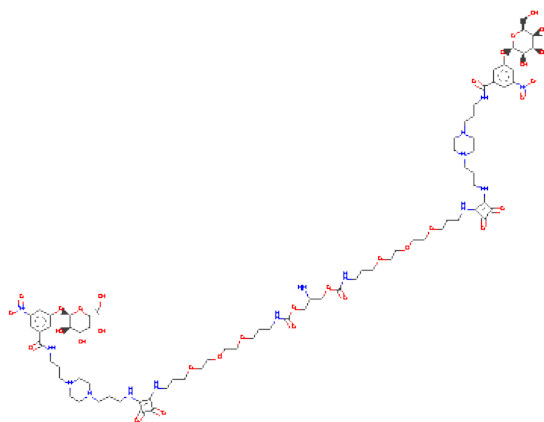
There are 5 unique types of molecules in this entry. The entry contains 4710 atoms, of which 0 are hydrogen and 0 are deuterium.

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 cholera toxin B protein (CTB).

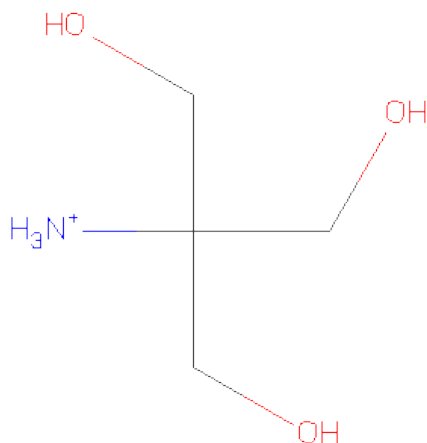
Mol	Chain	Residues	Atoms					ZeroOcc	AltConf	Trace
1	D	103	Total	C	N	O	S	0	0	0
			814	511	142	156	5			
1	E	103	Total	C	N	O	S	0	0	0
			814	511	142	156	5			
1	F	103	Total	C	N	O	S	0	1	0
			818	513	142	158	5			
1	G	103	Total	C	N	O	S	0	0	0
			814	511	142	156	5			
1	H	103	Total	C	N	O	S	0	0	0
			814	511	142	156	5			

- Molecule 2 is 1,3-BIS-([3-[3-[3-(4-{3-[3-NITRO-5-(GALACTOPYRANOSYLOXY)-BENZOYLAMINO]-PROPYL}-PIPERAZIN-1-YL)-PROPYLAMINO-3,4-DIOXO-CYCLOBUTENYL]-AMINO-PROPOXY-ETHOXY-ETHOXY]-PROPYL]-AMINO-CARBONYLOXY)-2-AMINO-PROPANE (three-letter code: BV4) (formula: C<sub>79</sub>H<sub>123</sub>N<sub>15</sub>O<sub>32</sub>).



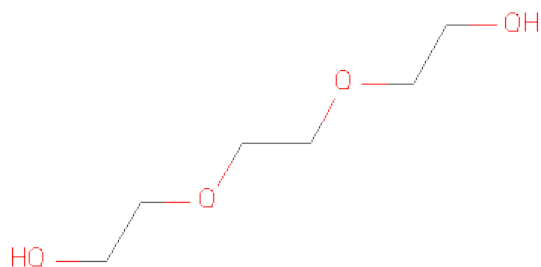
Mol	Chain	Residues	Atoms				ZeroOcc	AltConf
2	D	1	Total	C	N	O	0	0
			24	13	2	9		
2	E	1	Total	C	N	O	0	0
			24	13	2	9		
2	F	1	Total	C	N	O	0	0
			24	13	2	9		
2	G	1	Total	C	N	O	0	0
			24	13	2	9		
2	H	1	Total	C	N	O	0	0
			24	13	2	9		

- Molecule 3 is 2-AMINO-2-HYDROXYMETHYL-PROPANE-1,3-DIOL (three-letter code: TRS) (formula:  $C_4H_{12}NO_3$ ).



Mol	Chain	Residues	Atoms				ZeroOcc	AltConf
3	H	1	Total	C	N	O	0	0
			8	4	1	3		

- Molecule 4 is TRIETHYLENE GLYCOL (three-letter code: PGE) (formula:  $C_6H_{14}O_4$ ).



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

- Molecule 5 is water.

Mol	Chain	Residues	Atoms		ZeroOcc	AltConf
5	D	92	Total	O	0	0
			92	92		
5	E	106	Total	O	0	0
			106	106		
5	F	95	Total	O	0	0
			95	95		
5	G	101	Total	O	0	0
			101	101		
5	H	104	Total	O	0	0
			104	104		

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- Molecule 1: cholera toxin B protein (CTB)

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Diagram illustrating a protein structure with residues T1, Q16, I17, H18, M37, D59, N89, and N103. Residues T1, I17, and N103 are highlighted in red, while the others are in yellow.

- Molecule 1: cholera toxin B protein (CTB)

Diagram illustrating a protein structure with residues T1, P2, Q3, C9, H13, and N103. The residues are color-coded: T1, P2, and Q3 are yellow; C9, H13, and N103 are green. Red dots are positioned above T1, H13, and N103.

- Molecule 1: cholera toxin B protein (CTB)

Diagram illustrating a linear chain of nodes: T1 (green), D7 (yellow), E29 (yellow), and N103 (yellow). T1 and N103 are marked with red dots above them. The nodes are connected sequentially: T1 → D7 → E29 → N103.

- Molecule 1: cholera toxin B protein (CTB)

A diagram showing a sequence of nodes: T1, P2, K23, Q56, D59, K63, R73, and N103. T1 and N103 are orange, while P2, K23, Q56, D59, K63, and R73 are yellow. Green lines connect P2 to K23, K23 to Q56, Q56 to D59, D59 to K63, K63 to R73, and R73 to N103. Red dots are above T1 and N103.

## 4 Data and refinement statistics

Property	Value	Source
Space group	C 1 2 1	Depositor
Cell constants a, b, c, $\alpha$ , $\beta$ , $\gamma$	102.23Å 66.03Å 78.64Å 90.00° 105.80° 90.00°	Depositor
Resolution (Å)	49.39 – 1.35 49.19 – 1.35	Depositor EDS
% Data completeness (in resolution range)	93.9 (49.39-1.35) 93.9 (49.19-1.35)	Depositor EDS
$R_{merge}$	0.08	Depositor
$R_{sym}$	(Not available)	Depositor
$\langle I/\sigma(I) \rangle$ <sup>1</sup>	1.82 (at 1.35Å)	Xtriage
Refinement program	REFMAC 5.1.24	Depositor
R, $R_{free}$	0.132 , 0.174 0.168 , 0.200	Depositor DCC
$R_{free}$ test set	5214 reflections (5.00%)	DCC
Wilson B-factor (Å <sup>2</sup> )	13.5	Xtriage
Anisotropy	0.409	Xtriage
Bulk solvent $k_{sol}$ (e/Å <sup>3</sup> ), $B_{sol}$ (Å <sup>2</sup> )	0.39 , 42.8	EDS
Estimated twinning fraction	No twinning to report.	Xtriage
L-test for twinning	$\langle  L  \rangle = 0.50$ , $\langle L^2 \rangle = 0.34$	Xtriage
Outliers	3 of 104314 reflections (0.003%)	Xtriage
$F_o, F_c$ correlation	0.97	EDS
Total number of atoms	4710	wwPDB-VP
Average B, all atoms (Å <sup>2</sup> )	13.0	wwPDB-VP

Xtriage's analysis on translational NCS is as follows: *The largest off-origin peak in the Patterson function is 7.34% 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: TRS, PGE, BV4

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	D	0.54	0/828	0.75	1/1118 (0.1%)
1	E	0.59	0/828	0.76	1/1118 (0.1%)
1	F	0.52	0/836	0.76	0/1129
1	G	0.58	0/828	0.77	1/1118 (0.1%)
1	H	0.56	0/828	0.76	1/1118 (0.1%)
All	All	0.56	0/4148	0.76	4/5601 (0.1%)

There are no bond length outliers.

All (4) bond angle outliers are listed below:

Mol	Chain	Res	Type	Atoms	Z	Observed(°)	Ideal(°)
1	D	59	ASP	CB-CG-OD2	6.51	124.16	118.30
1	H	73	ARG	NE-CZ-NH1	6.07	123.33	120.30
1	G	7	ASP	CB-CG-OD2	5.88	123.59	118.30
1	E	59	ASP	CB-CG-OD2	5.62	123.36	118.30

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	D	814	0	0	4	0
1	E	814	0	0	2	0
1	F	818	0	0	0	0
1	G	814	0	0	0	0
1	H	814	0	0	8	0
2	D	24	0	0	0	0
2	E	24	0	0	0	0
2	F	24	0	0	0	0
2	G	24	0	0	0	0
2	H	24	0	0	0	0
3	H	8	0	0	0	0
4	H	10	0	0	4	0
5	D	92	0	0	2	0
5	E	106	0	0	0	0
5	F	95	0	0	0	0
5	G	101	0	0	0	0
5	H	104	0	0	2	0
All	All	4710	0	0	12	0

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.

The worst 5 of 12 close contacts within the same asymmetric unit are listed below.

Atom-1	Atom-2	Distance(Å)	Clash(Å)
1:H:1:THR:CG2	5:H:1472:HOH:O	2.45	0.64
1:H:1:THR:OG1	4:H:110:PGE:C3	2.46	0.63
1:H:23:LYS:NZ	5:H:1498:HOH:O	2.35	0.58
1:H:1:THR:CG2	4:H:110:PGE:O2	2.52	0.56
1:D:1:THR:CG2	1:E:37:MET:CE	2.84	0.56

There are no symmetry-related clashes.

## 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	D	101/103 (98%)	100 (99%)	1 (1%)	0	100	100
1	E	101/103 (98%)	100 (99%)	1 (1%)	0	100	100
1	F	102/103 (99%)	101 (99%)	1 (1%)	0	100	100
1	G	101/103 (98%)	100 (99%)	1 (1%)	0	100	100
1	H	101/103 (98%)	100 (99%)	1 (1%)	0	100	100
All	All	506/515 (98%)	501 (99%)	5 (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	D	89/89 (100%)	87 (98%)	2 (2%)	64	27
1	E	89/89 (100%)	88 (99%)	1 (1%)	84	58
1	F	90/89 (101%)	87 (97%)	3 (3%)	50	13
1	G	89/89 (100%)	87 (98%)	2 (2%)	64	27
1	H	89/89 (100%)	84 (94%)	5 (6%)	30	3
All	All	446/445 (100%)	433 (97%)	13 (3%)	55	16

5 of 13 residues with a non-rotameric sidechain are listed below:

Mol	Chain	Res	Type
1	F	9	CYS
1	G	29	GLU
1	H	59	ASP
1	F	3	GLN
1	H	56	GLN

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 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 ⓘ

7 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	BV4	D	104	-	24,25,133	3.40	3 (12%)	34,36,175	1.29	3 (8%)
2	BV4	E	105	-	24,25,133	3.20	4 (16%)	34,36,175	1.13	3 (8%)
2	BV4	F	106	-	24,25,133	2.74	3 (12%)	34,36,175	1.16	5 (14%)
2	BV4	G	107	-	24,25,133	2.71	3 (12%)	34,36,175	1.08	4 (11%)
2	BV4	H	108	-	24,25,133	3.47	4 (16%)	34,36,175	1.18	2 (5%)
3	TRS	H	109	-	7,7,7	0.71	0	9,9,9	1.24	1 (11%)
4	PGE	H	110	-	9,9,9	0.55	0	8,8,8	1.13	1 (12%)

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	BV4	D	104	-	-	0/14/34/194	0/2/2/8
2	BV4	E	105	-	-	0/14/34/194	0/2/2/8

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Mol	Type	Chain	Res	Link	Chirals	Torsions	Rings
2	BV4	F	106	-	-	0/14/34/194	0/2/2/8
2	BV4	G	107	-	-	0/14/34/194	0/2/2/8
2	BV4	H	108	-	-	0/14/34/194	0/2/2/8
3	TRS	H	109	-	-	0/9/9/9	0/0/0/0
4	PGE	H	110	-	-	0/7/7/7	0/0/0/0

The worst 5 of 17 bond length outliers are listed below:

Mol	Chain	Res	Type	Atoms	Z	Observed(Å)	Ideal(Å)
2	H	108	BV4	O26-N14	13.12	1.44	1.23
2	D	104	BV4	O26-N14	11.88	1.42	1.23
2	E	105	BV4	O26-N14	10.76	1.40	1.23
2	F	106	BV4	O26-N14	8.66	1.37	1.23
2	E	105	BV4	C68-N14	-8.22	1.33	1.46

The worst 5 of 19 bond angle outliers are listed below:

Mol	Chain	Res	Type	Atoms	Z	Observed(°)	Ideal(°)
2	E	105	BV4	C66-O25-C74	-4.48	111.73	118.00
2	D	104	BV4	C69-C68-N14	4.16	122.00	118.71
2	H	108	BV4	C69-C68-N14	3.85	121.75	118.71
2	D	104	BV4	C66-O25-C74	-3.84	112.62	118.00
2	D	104	BV4	O27-N14-C68	3.30	120.75	114.42

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	D	103/103 (100%)	-0.10	3 (2%)	49	56	6, 10, 20, 30	0
1	E	103/103 (100%)	-0.09	3 (2%)	49	56	7, 11, 18, 34	0
1	F	103/103 (100%)	0.00	3 (2%)	49	56	8, 12, 19, 36	0
1	G	103/103 (100%)	-0.19	2 (1%)	64	71	7, 10, 18, 35	0
1	H	103/103 (100%)	-0.16	2 (1%)	64	71	7, 9, 16, 35	1 (0%)
All	All	515/515 (100%)	-0.11	13 (2%)	54	61	6, 10, 19, 36	1 (0%)

The worst 5 of 13 RSRZ outliers are listed below:

Mol	Chain	Res	Type	RSRZ
1	D	1	THR	5.3
1	E	1	THR	5.0
1	G	1	THR	5.0
1	F	103	ASN	4.7
1	H	103	ASN	4.6

### 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
2	BV4	H	108	24/126	0.11	4.52	10,15,34,37	0
2	BV4	G	107	24/126	0.10	2.79	13,16,29,36	0
4	PGE	H	110	10/10	0.17	1.66	19,30,35,42	0
2	BV4	E	105	24/126	0.10	0.99	14,19,31,37	0
3	TRS	H	109	8/8	0.12	0.63	17,19,23,26	0
2	BV4	F	106	24/126	0.09	0.40	15,19,27,33	0
2	BV4	D	104	24/126	0.08	-0.02	15,19,32,33	0

## 6.5 Other polymers ⓘ

There are no such residues in this entry.