



wwPDB X-ray Structure Validation Summary Report ⓘ

Apr 25, 2022 – 07:15 pm BST

PDB ID : 2W2D
Title : Crystal Structure of a Catalytically Active, Non-toxic Endopeptidase Derivative of Clostridium botulinum Toxin A
Authors : Masuyer, G.; Thiyagarajan, N.; James, P.L.; Marks, P.M.H.; Chaddock, J.A.; Acharya, K.R.
Deposited on : 2008-10-29
Resolution : 2.59 Å(reported)

This is a wwPDB X-ray Structure Validation Summary Report for a publicly released PDB entry.

We welcome your comments at 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 following versions of software and data (see [references ⓘ](#)) were used in the production of this report:

MolProbity : 4.02b-467
Mogul : 1.8.4, CSD as541be (2020)
Xtriage (Phenix) : 1.13
EDS : 2.28
Percentile statistics : 20191225.v01 (using entries in the PDB archive December 25th 2019)
Refmac : 5.8.0267
CCP4 : 7.1.010 (Gargrove)
Ideal geometry (proteins) : Engh & Huber (2001)
Ideal geometry (DNA, RNA) : Parkinson et al. (1996)
Validation Pipeline (wwPDB-VP) : 2.28

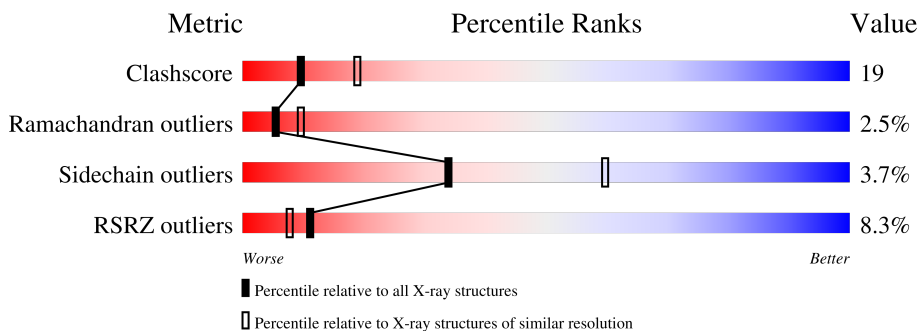
1 Overall quality at a glance

The following experimental techniques were used to determine the structure:

X-RAY DIFFRACTION

The reported resolution of this entry is 2.59 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))
Clashscore	141614	3518 (2.60-2.60)
Ramachandran outliers	138981	3455 (2.60-2.60)
Sidechain outliers	138945	3455 (2.60-2.60)
RSRZ outliers	127900	3104 (2.60-2.60)

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 ≥ 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	450	 2% 74% 21% ••
1	C	450	 % 75% 21% ••
2	B	431	 11% 65% 29% ••
2	D	431	 19% 51% 36% 6% • 5%

The following table lists non-polymeric compounds, carbohydrate monomers and non-standard residues in protein, DNA, RNA chains that are outliers for geometric or electron-density-fit criteria:

Mol	Type	Chain	Res	Chirality	Geometry	Clashes	Electron density
6	GOL	A	1436	-	X	-	-
6	GOL	A	1437	-	X	-	-
6	GOL	A	1438	-	X	-	-
6	GOL	B	1873	-	X	-	-
6	GOL	B	1874	-	X	-	-

2 Entry composition i

There are 8 unique types of molecules in this entry. The entry contains 14160 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 BOTULINUM NEUROTOXIN A LIGHT CHAIN.

Mol	Chain	Residues	Atoms					ZeroOcc	AltConf	Trace
			Total	C	N	O	S			
1	A	437	Total	C	N	O	S	0	0	1
			3534	2281	574	669	10			
1	C	436	Total	C	N	O	S	0	0	1
			3522	2273	573	666	10			

There are 4 discrepancies between the modelled and reference sequences:

Chain	Residue	Modelled	Actual	Comment	Reference
A	2	GLU	PRO	conflict	UNP A5HZZ9
A	432	ASP	ARG	conflict	UNP A5HZZ9
C	2	GLU	PRO	conflict	UNP A5HZZ9
C	432	ASP	ARG	conflict	UNP A5HZZ9

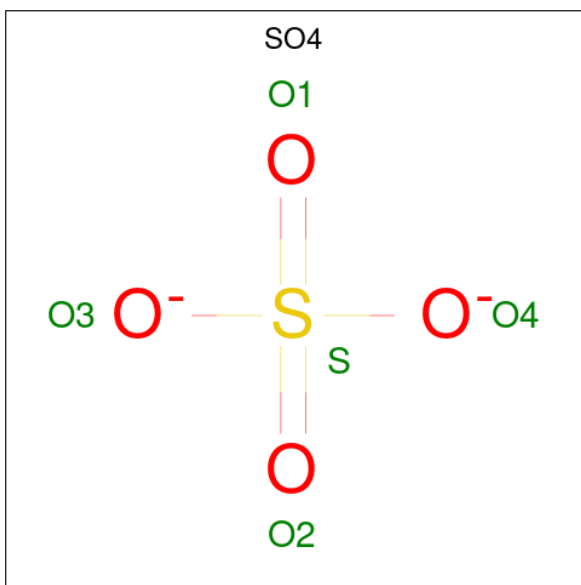
- Molecule 2 is a protein called BOTULINUM NEUROTOXIN A HEAVY CHAIN.

Mol	Chain	Residues	Atoms					ZeroOcc	AltConf	Trace
			Total	C	N	O	S			
2	B	424	Total	C	N	O	S	0	0	1
			3429	2195	550	674	10			
2	D	408	Total	C	N	O	S	0	0	1
			3308	2119	529	650	10			

There are 4 discrepancies between the modelled and reference sequences:

Chain	Residue	Modelled	Actual	Comment	Reference
B	452	LEU	ASP	conflict	UNP A5HZZ9
B	453	GLN	LEU	conflict	UNP A5HZZ9
D	452	LEU	ASP	conflict	UNP A5HZZ9
D	453	GLN	LEU	conflict	UNP A5HZZ9

- Molecule 3 is SULFATE ION (three-letter code: SO4) (formula: O₄S).



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

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

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

- Molecule 5 is CHLORIDE ION (three-letter code: CL) (formula: Cl).

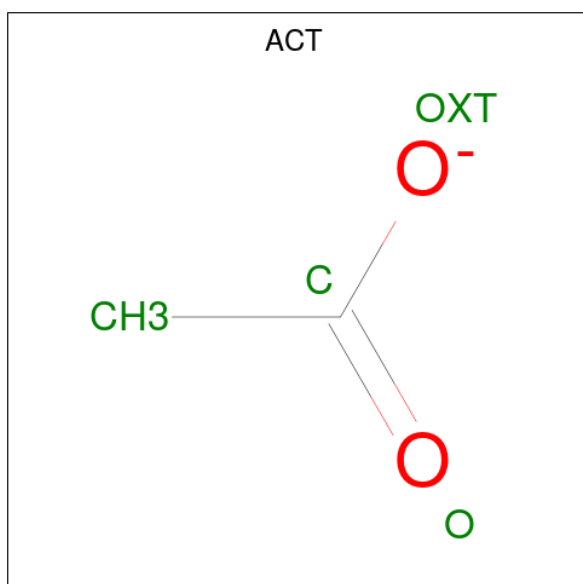
Mol	Chain	Residues	Atoms	ZeroOcc	AltConf
5	A	2	Total Cl 2 2	0	0
5	D	1	Total Cl 1 1	0	0

- Molecule 6 is GLYCEROL (three-letter code: GOL) (formula: C₃H₈O₃).



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

- Molecule 7 is ACETATE ION (three-letter code: ACT) (formula: $C_2H_3O_2^-$).



Mol	Chain	Residues	Atoms			ZeroOcc	AltConf
7	C	1	Total	C	O	0	0
			4	2	2		

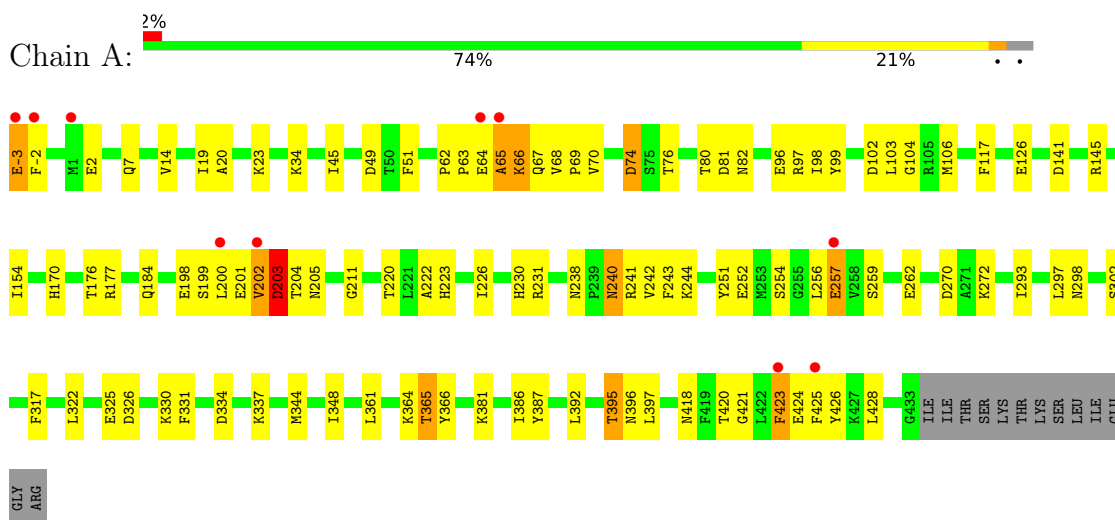
- Molecule 8 is water.

Mol	Chain	Residues	Atoms		ZeroOcc	AltConf
8	A	110	Total	O	0	0
			110	110		
8	B	49	Total	O	0	0
			49	49		
8	C	118	Total	O	0	0
			118	118		
8	D	31	Total	O	0	0
			31	31		

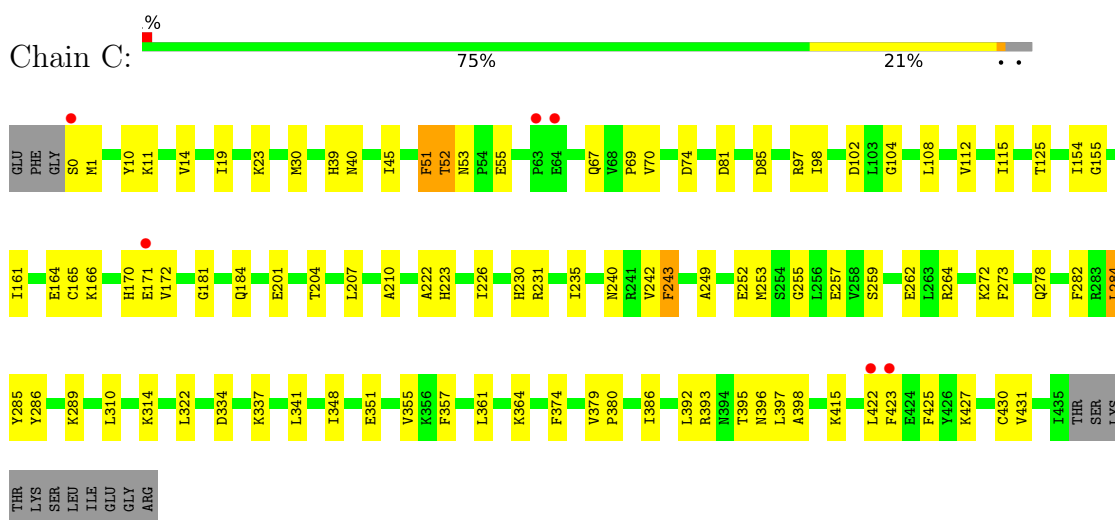
3 Residue-property plots [i](#)

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: BOTULINUM NEUROTOXIN A LIGHT CHAIN

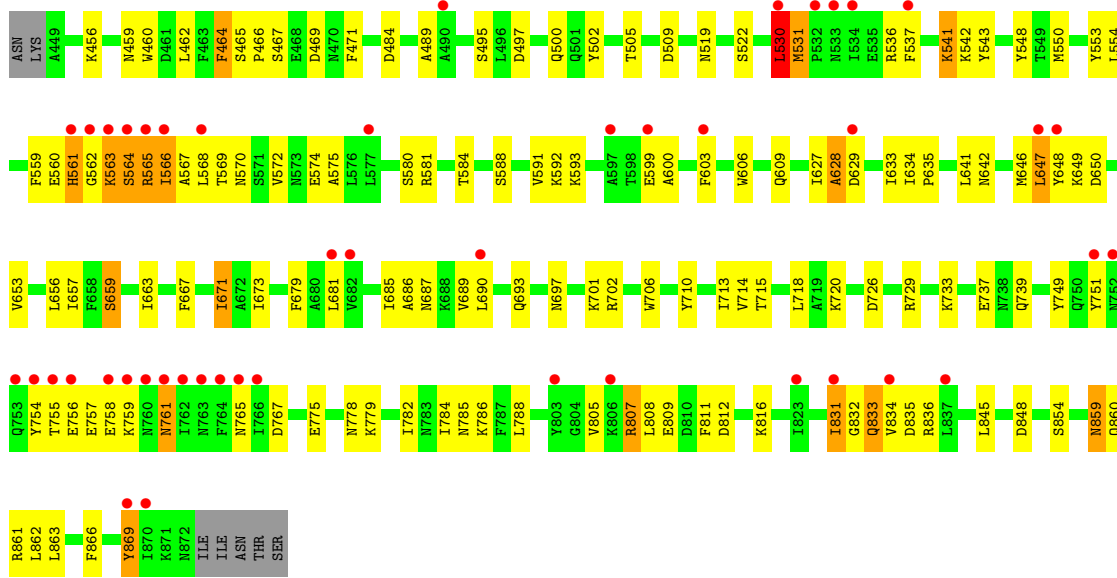


- Molecule 1: BOTULINUM NEUROTOXIN A LIGHT CHAIN

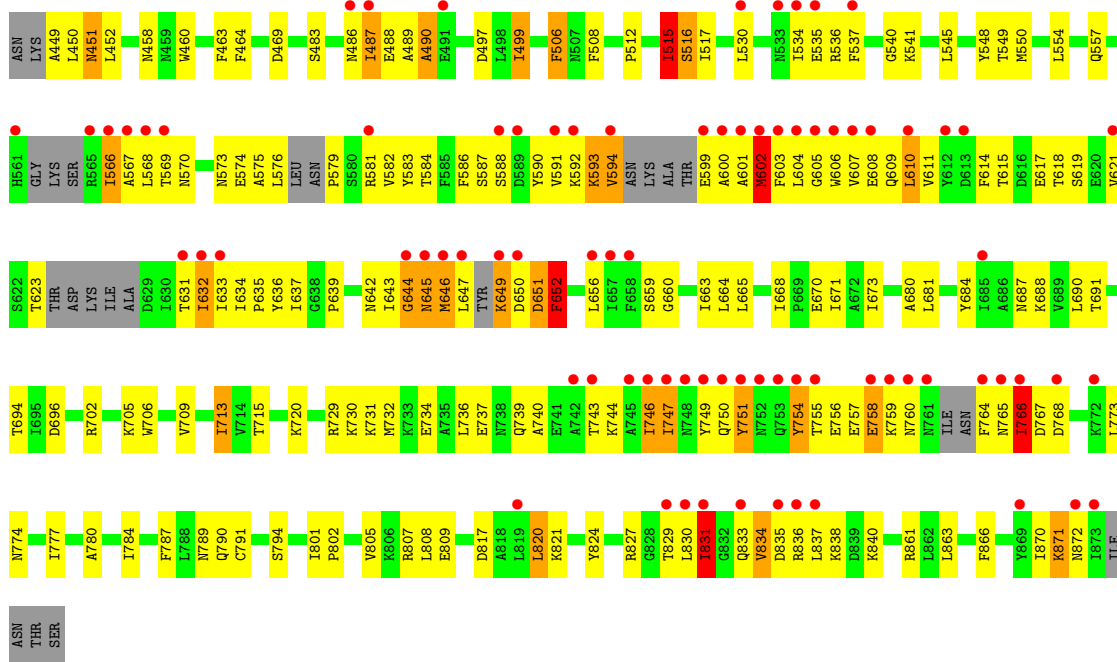


- Molecule 2: BOTULINUM NEUROTOXIN A HEAVY CHAIN





● Molecule 2: BOTULINUM NEUROTOXIN A HEAVY CHAIN



4 Data and refinement statistics

Property	Value	Source
Space group	P 21 21 21	Depositor
Cell constants a, b, c, α , β , γ	78.36Å 156.91Å 211.65Å 90.00° 90.00° 90.00°	Depositor
Resolution (Å)	49.11 – 2.59 49.11 – 2.59	Depositor EDS
% Data completeness (in resolution range)	91.2 (49.11-2.59) 91.1 (49.11-2.59)	Depositor EDS
R_{merge}	0.11	Depositor
R_{sym}	(Not available)	Depositor
$\langle I/\sigma(I) \rangle$ ¹	1.82 (at 2.58Å)	Xtriage
Refinement program	CNS 1.2	Depositor
R, R_{free}	0.212 , 0.253 0.215 , (Not available)	Depositor DCC
R_{free} test set	No test flags present.	wwPDB-VP
Wilson B-factor (Å ²)	34.3	Xtriage
Anisotropy	0.240	Xtriage
Bulk solvent k_{sol} (e/Å ³), B_{sol} (Å ²)	(Not available) , (Not available)	EDS
L-test for twinning ²	$\langle L \rangle = 0.49$, $\langle L^2 \rangle = 0.32$	Xtriage
Estimated twinning fraction	No twinning to report.	Xtriage
F_o, F_c correlation	0.92	EDS
Total number of atoms	14160	wwPDB-VP
Average B, all atoms (Å ²)	40.0	wwPDB-VP

Xtriage's analysis on translational NCS is as follows: *The largest off-origin peak in the Patterson function is 2.61% of the height of the origin peak. No significant pseudotranslation is detected.*

¹Intensities estimated from amplitudes.

²Theoretical 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 [i](#)

5.1 Standard geometry [i](#)

Bond lengths and bond angles in the following residue types are not validated in this section: ZN, SO4, GOL, CL, ACT

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	0.49	0/3618	0.64	0/4896
1	C	0.51	0/3605	0.63	0/4879
2	B	0.48	0/3492	0.61	0/4735
2	D	0.45	0/3364	0.66	3/4552 (0.1%)
All	All	0.48	0/14079	0.64	3/19062 (0.0%)

There are no bond length outliers.

All (3) bond angle outliers are listed below:

Mol	Chain	Res	Type	Atoms	Z	Observed(°)	Ideal(°)
2	D	652	PHE	CB-CG-CD1	-9.74	113.98	120.80
2	D	652	PHE	CB-CG-CD2	6.02	125.02	120.80
2	D	831	ILE	CB-CA-C	-5.11	101.38	111.60

There are no chirality outliers.

There are no planarity outliers.

5.2 Too-close contacts [i](#)

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	3534	0	3471	108	0
1	C	3522	0	3467	79	0
2	B	3429	0	3392	136	0
2	D	3308	0	3258	249	0

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Mol	Chain	Non-H	H(model)	H(added)	Clashes	Symm-Clashes
3	A	5	0	0	0	0
3	B	5	0	0	0	0
3	C	10	0	0	0	0
4	A	1	0	0	0	0
4	C	1	0	0	0	0
5	A	2	0	0	1	0
5	D	1	0	0	0	0
6	A	18	0	9	1	0
6	B	12	0	6	0	0
7	C	4	0	3	0	0
8	A	110	0	0	4	0
8	B	49	0	0	3	0
8	C	118	0	0	1	0
8	D	31	0	0	4	0
All	All	14160	0	13606	534	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 19.

The worst 5 of 534 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)
2:D:831:ILE:CG2	2:D:831:ILE:O	1.67	1.35
1:A:200:LEU:HG	2:B:861:ARG:NH1	1.46	1.30
2:D:649:LYS:CD	2:D:649:LYS:O	1.89	1.21
1:A:202:VAL:O	1:A:204:THR:N	1.74	1.19
2:D:659:SER:HB2	2:D:663:ILE:HD11	1.22	1.18

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	435/450 (97%)	405 (93%)	23 (5%)	7 (2%)	9	19
1	C	434/450 (96%)	408 (94%)	24 (6%)	2 (0%)	29	52
2	B	422/431 (98%)	379 (90%)	29 (7%)	14 (3%)	4	6
2	D	394/431 (91%)	341 (86%)	34 (9%)	19 (5%)	2	2
All	All	1685/1762 (96%)	1533 (91%)	110 (6%)	42 (2%)	5	9

5 of 42 Ramachandran outliers are listed below:

Mol	Chain	Res	Type
1	A	65	ALA
1	A	66	LYS
1	A	67	GLN
1	A	202	VAL
1	A	203	ASP

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	390/402 (97%)	380 (97%)	10 (3%)	46	72
1	C	389/402 (97%)	383 (98%)	6 (2%)	65	83
2	B	385/393 (98%)	370 (96%)	15 (4%)	32	58
2	D	372/393 (95%)	346 (93%)	26 (7%)	15	30
All	All	1536/1590 (97%)	1479 (96%)	57 (4%)	34	60

5 of 57 residues with a non-rotameric sidechain are listed below:

Mol	Chain	Res	Type
1	C	240	ASN
2	D	831	ILE
2	D	506	PHE
2	D	820	LEU
2	D	747	ILE

Sometimes sidechains can be flipped to improve hydrogen bonding and reduce clashes. 5 of 23 such sidechains are listed below:

Mol	Chain	Res	Type
1	C	82	ASN
1	C	269	HIS
1	C	174	ASN
1	C	394	ASN
2	B	570	ASN

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 monosaccharides in this entry.

5.6 Ligand geometry [i](#)

Of 15 ligands modelled in this entry, 5 are monoatomic - leaving 10 for Mogul analysis.

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	$\# Z > 2$
6	GOL	A	1436	-	5,5,5	4.56	5 (100%)	5,5,5	5.80	3 (60%)
3	SO4	A	1433	-	4,4,4	0.30	0	6,6,6	0.10	0
3	SO4	C	1436	-	4,4,4	0.30	0	6,6,6	0.10	0
6	GOL	A	1438	-	5,5,5	4.57	5 (100%)	5,5,5	5.74	3 (60%)
6	GOL	B	1873	-	5,5,5	4.48	5 (100%)	5,5,5	5.77	3 (60%)
3	SO4	B	1872	-	4,4,4	0.27	0	6,6,6	0.09	0

Mol	Type	Chain	Res	Link	Bond lengths			Bond angles		
					Counts	RMSZ	# Z > 2	Counts	RMSZ	# Z > 2
6	GOL	B	1874	-	5,5,5	4.54	5 (100%)	5,5,5	5.76	3 (60%)
6	GOL	A	1437	-	5,5,5	4.47	5 (100%)	5,5,5	5.80	3 (60%)
7	ACT	C	1435	-	1,3,3	1.87	0	0,3,3	-	-
3	SO4	C	1437	-	4,4,4	0.25	0	6,6,6	0.07	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
6	GOL	A	1436	-	-	3/4/4/4	-
6	GOL	A	1438	-	-	2/4/4/4	-
6	GOL	B	1873	-	-	2/4/4/4	-
6	GOL	B	1874	-	-	2/4/4/4	-
6	GOL	A	1437	-	-	2/4/4/4	-

The worst 5 of 25 bond length outliers are listed below:

Mol	Chain	Res	Type	Atoms	Z	Observed(Å)	Ideal(Å)
6	A	1438	GOL	C3-C2	-7.48	1.20	1.51
6	B	1873	GOL	C3-C2	-7.47	1.21	1.51
6	B	1874	GOL	C3-C2	-7.43	1.21	1.51
6	A	1436	GOL	C3-C2	-7.41	1.21	1.51
6	A	1437	GOL	C3-C2	-7.37	1.21	1.51

The worst 5 of 15 bond angle outliers are listed below:

Mol	Chain	Res	Type	Atoms	Z	Observed(°)	Ideal(°)
6	A	1437	GOL	O3-C3-C2	10.60	161.04	110.20
6	A	1436	GOL	O3-C3-C2	10.59	160.97	110.20
6	B	1873	GOL	O3-C3-C2	10.48	160.43	110.20
6	A	1438	GOL	O3-C3-C2	10.39	160.00	110.20
6	B	1874	GOL	O3-C3-C2	10.37	159.91	110.20

There are no chirality outliers.

5 of 11 torsion outliers are listed below:

Mol	Chain	Res	Type	Atoms
6	A	1436	GOL	O1-C1-C2-C3

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Mol	Chain	Res	Type	Atoms
6	A	1436	GOL	C1-C2-C3-O3
6	A	1437	GOL	C1-C2-C3-O3
6	A	1438	GOL	O1-C1-C2-C3
6	A	1438	GOL	C1-C2-C3-O3

There are no ring outliers.

1 monomer is involved in 1 short contact:

Mol	Chain	Res	Type	Clashes	Symm-Clashes
6	A	1436	GOL	1	0

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 [i](#)

6.1 Protein, DNA and RNA chains [i](#)

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, 95th 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 ²)	Q<0.9
1	A	437/450 (97%)	-0.08	10 (2%) 60 54	12, 27, 54, 98	0
1	C	436/450 (96%)	-0.07	6 (1%) 75 71	12, 30, 59, 75	0
2	B	424/431 (98%)	0.52	46 (10%) 5 3	20, 42, 78, 93	0
2	D	408/431 (94%)	1.06	80 (19%) 1 0	21, 48, 101, 117	0
All	All	1705/1762 (96%)	0.34	142 (8%) 11 8	12, 36, 78, 117	0

The worst 5 of 142 RSRZ outliers are listed below:

Mol	Chain	Res	Type	RSRZ
2	D	873	ILE	13.1
2	D	602	MET	9.3
2	D	764	PHE	8.6
2	D	872	ASN	8.1
2	D	755	THR	8.0

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 monosaccharides 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, 95th 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(\AA^2)	Q<0.9
6	GOL	B	1873	6/6	0.81	0.20	51,53,55,56	0
6	GOL	A	1436	6/6	0.88	0.17	54,55,56,58	0
3	SO4	A	1433	5/5	0.92	0.20	68,69,70,72	0
3	SO4	C	1436	5/5	0.92	0.17	82,83,85,85	0
6	GOL	B	1874	6/6	0.92	0.16	55,59,59,60	0
7	ACT	C	1435	4/4	0.92	0.19	49,50,51,52	0
6	GOL	A	1437	6/6	0.93	0.19	44,46,47,49	0
5	CL	D	1872	1/1	0.93	0.07	47,47,47,47	0
6	GOL	A	1438	6/6	0.94	0.18	54,55,56,58	0
3	SO4	C	1437	5/5	0.94	0.12	69,69,70,70	0
5	CL	A	1435	1/1	0.95	0.10	44,44,44,44	0
5	CL	A	1439	1/1	0.97	0.14	44,44,44,44	0
3	SO4	B	1872	5/5	0.97	0.14	47,48,50,51	0
4	ZN	C	1438	1/1	1.00	0.18	29,29,29,29	0
4	ZN	A	1434	1/1	1.00	0.14	23,23,23,23	0

6.5 Other polymers [i](#)

There are no such residues in this entry.