



Full wwPDB X-ray Structure Validation Report ⓘ

Mar 9, 2026 – 07:57 AM UTC

PDB ID : 2CBU / pdb_00002cbu
Title : Beta-glucosidase from *Thermotoga maritima* in complex with castanospermine
Authors : Gloster, T.M.; Davies, G.J.; Madsen, R.
Deposited on : 2006-01-09
Resolution : 1.85 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

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>.

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

MolProbity	:	4-5-2 with Phenix2.0
Mogul	:	2022.3.0, CSD as543be (2022)
Xtriage (Phenix)	:	2.0
EDS	:	3.0
Percentile statistics	:	20250101.v01 (using entries in the PDB archive January 1st 2025)
CCP4	:	9.0.010 (Gargrove)
Density-Fitness	:	1.0.12
Ideal geometry (proteins)	:	Engh & Huber (2001)
Ideal geometry (DNA, RNA)	:	Parkinson et al. (1996)
Validation Pipeline (wwPDB-VP)	:	2.49

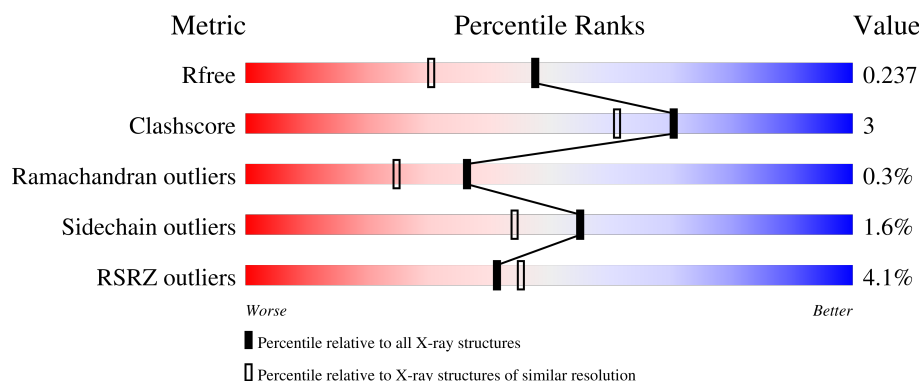
1 Overall quality at a glance

The following experimental techniques were used to determine the structure:

X-RAY DIFFRACTION

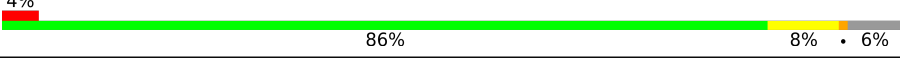
The reported resolution of this entry is 1.85 Å.

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}	180053	3428 (1.86-1.86)
Clashscore	190562	3579 (1.86-1.86)
Ramachandran outliers	187476	3553 (1.86-1.86)
Sidechain outliers	187428	3553 (1.86-1.86)
RSRZ outliers	180081	3429 (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 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	468	 4% 88% 5% • 6%
1	B	468	 4% 86% 8% • 6%

2 Entry composition [i](#)

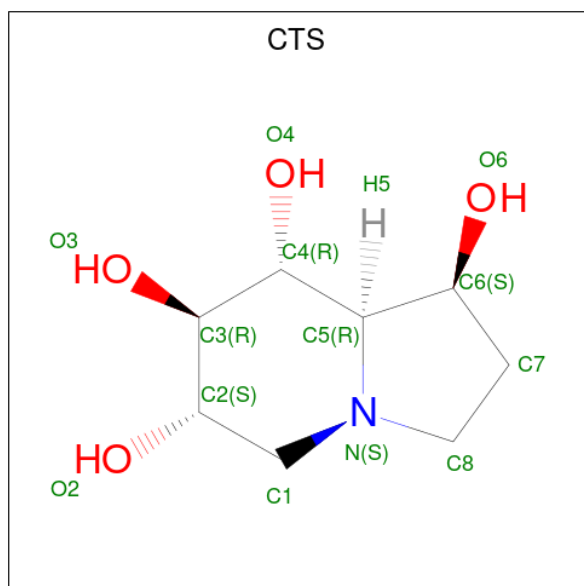
There are 5 unique types of molecules in this entry. The entry contains 8225 atoms, of which 0 are hydrogens and 0 are deuteriums.

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 BETA-GLUCOSIDASE A.

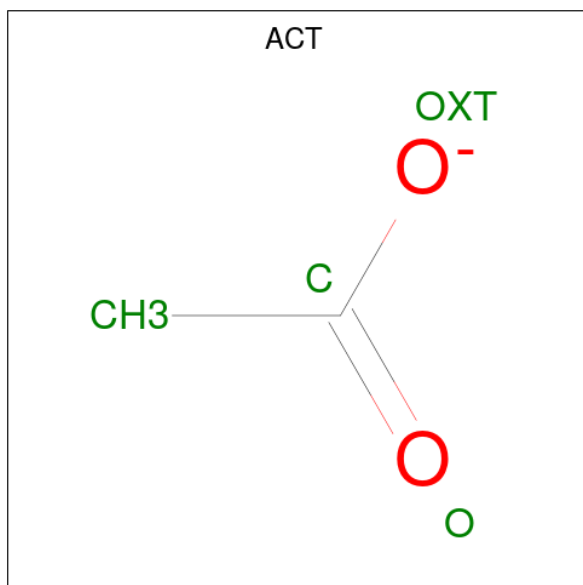
Mol	Chain	Residues	Atoms					ZeroOcc	AltConf	Trace
1	A	440	Total	C	N	O	S	0	16	0
			3694	2406	619	662	7			
1	B	441	Total	C	N	O	S	0	15	0
			3672	2388	613	664	7			

- Molecule 2 is CASTANOSPERMINE (CCD ID: CTS) (formula: $C_8H_{15}NO_4$).



Mol	Chain	Residues	Atoms				ZeroOcc	AltConf
2	A	1	Total	C	N	O	0	0
			13	8	1	4		
2	B	1	Total	C	N	O	0	0
			13	8	1	4		

- Molecule 3 is ACETATE ION (CCD ID: ACT) (formula: $C_2H_3O_2$).



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

- Molecule 4 is CALCIUM ION (CCD ID: CA) (formula: Ca).

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

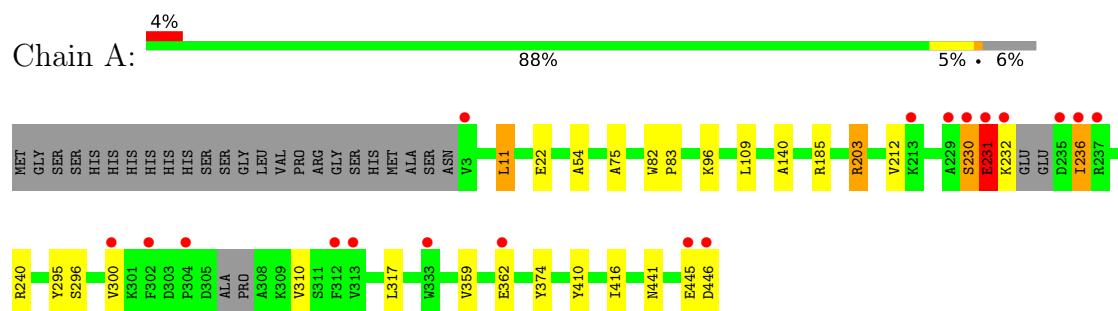
- Molecule 5 is water.

Mol	Chain	Residues	Atoms		ZeroOcc	AltConf
5	A	473	Total	O	0	0
			473	473		
5	B	351	Total	O	0	0
			351	351		

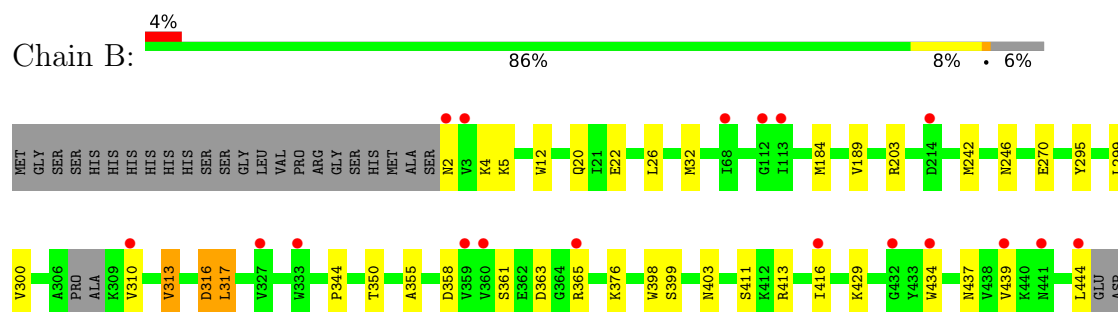
3 Residue-property plots

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: BETA-GLUCOSIDASE A



• Molecule 1: BETA-GLUCOSIDASE A



4 Data and refinement statistics

Property	Value	Source
Space group	P 21 21 21	Depositor
Cell constants a, b, c, α , β , γ	94.08Å 94.52Å 113.28Å 90.00° 90.00° 90.00°	Depositor
Resolution (Å)	72.55 – 1.85 72.55 – 1.85	Depositor EDS
% Data completeness (in resolution range)	99.8 (72.55-1.85) 99.9 (72.55-1.85)	Depositor EDS
R_{merge}	0.07	Depositor
R_{sym}	(Not available)	Depositor
$\langle I/\sigma(I) \rangle$ ¹	3.32 (at 1.85Å)	Xtriage
Refinement program	REFMAC 5.2.0005	Depositor
R, R_{free}	0.183 , 0.237 0.183 , 0.237	Depositor DCC
R_{free} test set	4397 reflections (5.06%)	wwPDB-VP
Wilson B-factor (Å ²)	25.3	Xtriage
Anisotropy	0.077	Xtriage
Bulk solvent k_{sol} (e/Å ³), B_{sol} (Å ²)	0.35 , 52.7	EDS
L-test for twinning ²	$\langle L \rangle = 0.50$, $\langle L^2 \rangle = 0.34$	Xtriage
Estimated twinning fraction	0.010 for k,h,-l	Xtriage
F_o, F_c correlation	0.96	EDS
Total number of atoms	8225	wwPDB-VP
Average B, all atoms (Å ²)	28.0	wwPDB-VP

Xtriage's analysis on translational NCS is as follows: *The largest off-origin peak in the Patterson function is 3.83% 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

5.1 Standard geometry

Bond lengths and bond angles in the following residue types are not validated in this section: CTS, CA, 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	0.84	0/3855	0.88	4/5227 (0.1%)
1	B	0.76	1/3823 (0.0%)	0.86	2/5195 (0.0%)
All	All	0.80	1/7678 (0.0%)	0.87	6/10422 (0.1%)

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	2

All (1) bond length outliers are listed below:

Mol	Chain	Res	Type	Atoms	Z	Observed(Å)	Ideal(Å)
1	B	344	PRO	CA-C	5.54	1.54	1.51

All (6) bond angle outliers are listed below:

Mol	Chain	Res	Type	Atoms	Z	Observed(°)	Ideal(°)
1	A	231	GLU	N-CA-C	-8.59	96.39	109.79
1	A	296	SER	N-CA-C	5.32	117.15	109.07
1	B	416	ILE	N-CA-C	-5.31	106.69	113.22
1	A	22	GLU	N-CA-C	5.29	117.12	111.36
1	B	22	GLU	N-CA-C	5.14	116.69	111.14
1	A	416	ILE	N-CA-C	-5.01	107.04	112.80

There are no chirality outliers.

All (2) planarity outliers are listed below:

Mol	Chain	Res	Type	Group
1	A	230	SER	Peptide
1	A	231	GLU	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	3694	0	3594	23	0
1	B	3672	0	3515	26	0
2	A	13	0	15	2	0
2	B	13	0	15	2	0
3	A	8	0	6	0	0
4	B	1	0	0	0	0
5	A	473	0	0	9	0
5	B	351	0	0	2	0
All	All	8225	0	7145	49	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 (49) 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:212:VAL:HG11	5:A:2239:HOH:O	1.66	0.94
1:B:270[B]:GLU:HG2	5:B:2239:HOH:O	1.74	0.87
1:B:242:MET:HE3	1:B:246[B]:ASN:ND2	1.90	0.86
1:A:230:SER:OG	1:A:231:GLU:O	1.99	0.79
1:B:242:MET:CE	1:B:246[B]:ASN:HD21	1.95	0.78
1:B:365[B]:ARG:CG	1:B:365[B]:ARG:HH11	1.99	0.76
1:B:295:TYR:CE2	2:B:1445:CTS:H81	2.22	0.74
1:B:365[B]:ARG:HH11	1:B:365[B]:ARG:HG2	1.54	0.71
1:A:295:TYR:CE1	2:A:1447:CTS:H81	2.26	0.70
1:B:242:MET:HE3	1:B:246[B]:ASN:HD21	1.52	0.70
1:B:316:ASP:O	1:B:317:LEU:O	2.10	0.69
1:B:365[B]:ARG:HG2	1:B:365[B]:ARG:NH1	2.11	0.63
1:A:230:SER:CB	1:A:231:GLU:O	2.48	0.61
1:B:26:LEU:HD21	1:B:32:MET:HG2	1.84	0.60

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Atom-1	Atom-2	Interatomic distance (Å)	Clash overlap (Å)
1:A:240:ARG:HD3	5:A:2296:HOH:O	2.03	0.59
1:A:203[A]:ARG:HG3	5:A:2264:HOH:O	2.04	0.58
1:A:362:GLU:HG3	5:A:2395:HOH:O	2.06	0.56
1:A:11:LEU:HG	1:A:75:ALA:HB2	1.89	0.54
1:A:230:SER:C	1:A:231:GLU:O	2.48	0.53
1:B:376:LYS:HG3	1:B:434:TRP:HZ2	1.74	0.52
1:A:300:VAL:HG13	1:A:310:VAL:HG13	1.92	0.51
1:B:361:SER:HB2	1:B:363:ASP:OD1	2.11	0.50
1:B:184[A]:MET:SD	1:B:189:VAL:HG11	2.52	0.50
1:A:96:LYS:NZ	5:A:2155:HOH:O	2.45	0.49
1:A:240:ARG:CD	5:A:2296:HOH:O	2.59	0.49
1:B:295:TYR:CZ	2:B:1445:CTS:H81	2.47	0.48
1:B:4[B]:LYS:HD2	1:B:444:LEU:HD12	1.96	0.48
1:B:300[B]:VAL:HG23	1:B:310:VAL:HG13	1.96	0.47
1:B:299:LEU:HD23	1:B:313:VAL:HG22	1.96	0.47
1:A:140:ALA:HB1	1:A:203[C]:ARG:HG3	1.96	0.47
1:B:242:MET:CE	1:B:246[B]:ASN:ND2	2.60	0.47
1:B:358:ASP:OD2	1:B:429:LYS:NZ	2.43	0.47
1:A:236:ILE:HD12	5:A:2142:HOH:O	2.14	0.46
1:B:434:TRP:O	1:B:437:ASN:HB2	2.17	0.45
1:B:12:TRP:HB3	1:B:439:VAL:HG22	1.99	0.44
1:A:362:GLU:HG2	5:A:2099:HOH:O	2.16	0.44
1:A:295:TYR:CZ	2:A:1447:CTS:H72	2.53	0.43
1:A:300:VAL:HG13	1:A:310:VAL:CG1	2.48	0.42
1:A:232:LYS:O	1:A:236:ILE:HG23	2.19	0.42
1:B:300[B]:VAL:CG2	1:B:310:VAL:HG13	2.49	0.42
1:A:54:ALA:HA	1:A:410:TYR:OH	2.20	0.41
1:B:398:TRP:HA	1:B:399:SER:HA	1.80	0.41
1:B:411:SER:HB3	5:B:2059:HOH:O	2.20	0.41
1:A:374:TYR:C	1:A:374:TYR:CD1	2.99	0.41
1:A:82:TRP:HB3	1:A:83:PRO:HD3	2.03	0.41
1:A:441:ASN:ND2	1:A:446:ASP:HA	2.36	0.41
1:B:20:GLN:O	1:B:403:ASN:HB2	2.21	0.41
1:A:203[A]:ARG:NH2	5:A:2265:HOH:O	2.54	0.40
1:B:355:ALA:HA	1:B:413:ARG:O	2.21	0.40

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	A	451/468 (96%)	441 (98%)	8 (2%)	2 (0%)	30	17
1	B	452/468 (97%)	440 (97%)	10 (2%)	2 (0%)	30	17
All	All	903/936 (96%)	881 (98%)	18 (2%)	4 (0%)	36	17

All (4) Ramachandran outliers are listed below:

Mol	Chain	Res	Type
1	B	316	ASP
1	B	317	LEU
1	A	445[A]	GLU
1	A	445[B]	GLU

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	A	388/399 (97%)	379 (98%)	9 (2%)	44	30
1	B	381/399 (96%)	375 (98%)	6 (2%)	55	44
All	All	769/798 (96%)	754 (98%)	15 (2%)	55	36

All (15) residues with a non-rotameric sidechain are listed below:

Mol	Chain	Res	Type
1	A	11	LEU
1	A	109	LEU

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Mol	Chain	Res	Type
1	A	185	ARG
1	A	203[A]	ARG
1	A	203[B]	ARG
1	A	203[C]	ARG
1	A	236	ILE
1	A	317	LEU
1	A	359	VAL
1	B	2	ASN
1	B	5	LYS
1	B	203[A]	ARG
1	B	203[B]	ARG
1	B	313	VAL
1	B	350	THR

Sometimes sidechains can be flipped to improve hydrogen bonding and reduce clashes. All (8) such sidechains are listed below:

Mol	Chain	Res	Type
1	A	59	ASN
1	A	129	GLN
1	A	253	ASN
1	A	387	GLN
1	B	253	ASN
1	B	352	ASN
1	B	387	GLN
1	B	441	ASN

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 oligosaccharides in this entry.

5.6 Ligand geometry

Of 5 ligands modelled in this entry, 1 is monoatomic - leaving 4 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
2	CTS	A	1447	-	14,14,14	0.71	1 (7%)	17,21,21	2.67	6 (35%)
3	ACT	A	1448	-	3,3,3	0.79	0	3,3,3	2.07	2 (66%)
3	ACT	A	1449	-	3,3,3	0.88	0	3,3,3	1.27	0
2	CTS	B	1445	-	14,14,14	0.55	0	17,21,21	2.59	7 (41%)

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	CTS	A	1447	-	-	-	0/2/2/2
2	CTS	B	1445	-	-	-	0/2/2/2

All (1) bond length outliers are listed below:

Mol	Chain	Res	Type	Atoms	Z	Observed(Å)	Ideal(Å)
2	A	1447	CTS	C6-C5	-2.31	1.52	1.54

All (15) bond angle outliers are listed below:

Mol	Chain	Res	Type	Atoms	Z	Observed(°)	Ideal(°)
2	A	1447	CTS	C1-N-C5	7.88	124.52	110.62
2	B	1445	CTS	C1-N-C5	7.59	124.00	110.62
2	A	1447	CTS	C1-C2-C3	4.24	115.20	110.17
2	B	1445	CTS	C2-C1-N	3.45	117.13	110.72
2	A	1447	CTS	O6-C6-C7	-3.19	103.94	111.43
2	B	1445	CTS	O6-C6-C7	-3.11	104.14	111.43
2	B	1445	CTS	C1-C2-C3	2.73	113.41	110.17
2	B	1445	CTS	C8-N-C1	2.64	122.28	113.50

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Mol	Chain	Res	Type	Atoms	Z	Observed(°)	Ideal(°)
3	A	1448	ACT	OXT-C-O	-2.62	112.29	122.03
2	B	1445	CTS	C8-N-C5	2.57	113.32	106.17
2	A	1447	CTS	C2-C1-N	2.56	115.48	110.72
2	A	1447	CTS	C8-N-C5	2.46	113.00	106.17
3	A	1448	ACT	OXT-C-CH3	2.44	125.30	115.05
2	A	1447	CTS	C8-N-C1	2.26	121.03	113.50
2	B	1445	CTS	O3-C3-C2	2.12	114.38	110.05

There are no chirality outliers.

There are no torsion outliers.

There are no ring outliers.

2 monomers are involved in 4 short contacts:

Mol	Chain	Res	Type	Clashes	Symm-Clashes
2	A	1447	CTS	2	0
2	B	1445	CTS	2	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

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, 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	440/468 (94%)	-0.12	18 (4%) 41 45	8, 23, 41, 56	16 (3%)
1	B	441/468 (94%)	0.37	18 (4%) 41 45	10, 29, 45, 56	15 (3%)
All	All	881/936 (94%)	0.13	36 (4%) 41 45	8, 25, 44, 56	31 (3%)

All (36) RSRZ outliers are listed below:

Mol	Chain	Res	Type	RSRZ
1	A	445[A]	GLU	4.0
1	A	236	ILE	3.8
1	B	333	TRP	3.4
1	A	232	LYS	3.3
1	A	229	ALA	3.3
1	A	446	ASP	3.0
1	A	3	VAL	3.0
1	A	230	SER	3.0
1	A	333	TRP	3.0
1	B	365[A]	ARG	2.9
1	B	434	TRP	2.9
1	B	441	ASN	2.7
1	A	235	ASP	2.7
1	A	213	LYS	2.6
1	B	360	VAL	2.6
1	B	416	ILE	2.6
1	A	300	VAL	2.5
1	B	3	VAL	2.5
1	B	359	VAL	2.5
1	B	2	ASN	2.5
1	B	432	GLY	2.4
1	B	113	ILE	2.4
1	A	362	GLU	2.4
1	B	112	GLY	2.4

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Mol	Chain	Res	Type	RSRZ
1	B	68	ILE	2.3
1	B	327	VAL	2.3
1	B	444	LEU	2.3
1	A	304	PRO	2.3
1	B	439	VAL	2.3
1	A	313	VAL	2.2
1	A	237	ARG	2.2
1	A	302	PHE	2.1
1	B	214	ASP	2.1
1	A	312	PHE	2.1
1	A	231	GLU	2.0
1	B	310	VAL	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 oligosaccharides 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($\text{\AA}^2$)	Q<0.9
3	ACT	A	1448	4/4	0.66	0.20	32,33,34,36	0
3	ACT	A	1449	4/4	0.80	0.20	49,49,49,49	0
2	CTS	A	1447	13/13	0.96	0.05	16,17,19,20	0
2	CTS	B	1445	13/13	0.96	0.05	22,24,26,27	0
4	CA	B	1446	1/1	0.98	0.12	33,33,33,33	0

6.5 Other polymers [i](#)

There are no such residues in this entry.