



Full wwPDB X-ray Structure Validation Report ⓘ

Mar 9, 2026 – 08:30 AM UTC

PDB ID : 3US9 / pdb_00003us9
Title : Crystal Structure of the NCX1 Intracellular Tandem Calcium Binding Domains(CBD12)
Authors : Giladi, M.; Sasson, Y.; Hirsch, J.A.; Khananshvili, D.
Deposited on : 2011-11-23
Resolution : 2.68 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
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

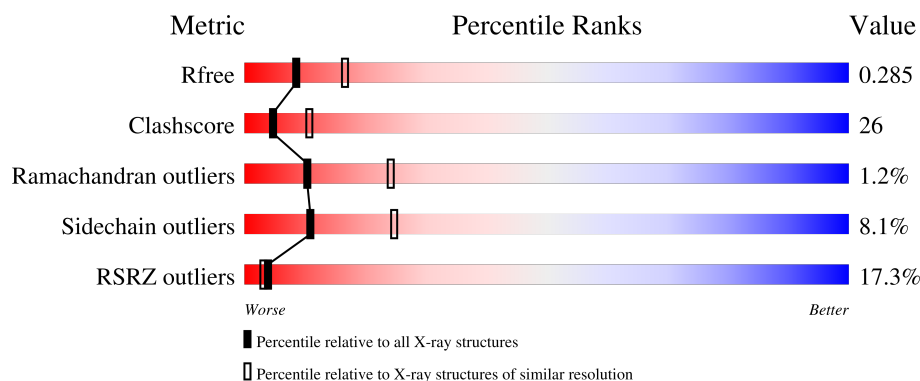
1 Overall quality at a glance

The following experimental techniques were used to determine the structure:

X-RAY DIFFRACTION

The reported resolution of this entry is 2.68 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	5070 (2.70-2.66)
Clashscore	190562	5409 (2.70-2.66)
Ramachandran outliers	187476	5324 (2.70-2.66)
Sidechain outliers	187428	5324 (2.70-2.66)
RSRZ outliers	180081	5070 (2.70-2.66)

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	295	15% 51% 29% • 16%

2 Entry composition

There are 3 unique types of molecules in this entry. The entry contains 1905 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 Sodium/calcium exchanger 1.

Mol	Chain	Residues	Atoms					ZeroOcc	AltConf	Trace
1	A	249	Total	C	N	O	S	0	0	0
			1890	1181	312	390	7			

There are 9 discrepancies between the modelled and reference sequences:

Chain	Residue	Modelled	Actual	Comment	Reference
A	363	MET	-	expression tag	UNP P23685
A	364	SER	-	expression tag	UNP P23685
A	365	HIS	-	expression tag	UNP P23685
A	366	HIS	-	expression tag	UNP P23685
A	367	HIS	-	expression tag	UNP P23685
A	368	HIS	-	expression tag	UNP P23685
A	369	HIS	-	expression tag	UNP P23685
A	370	HIS	-	expression tag	UNP P23685
A	454	LYS	GLU	engineered mutation	UNP P23685

- Molecule 2 is CALCIUM ION (CCD ID: CA) (formula: Ca).

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

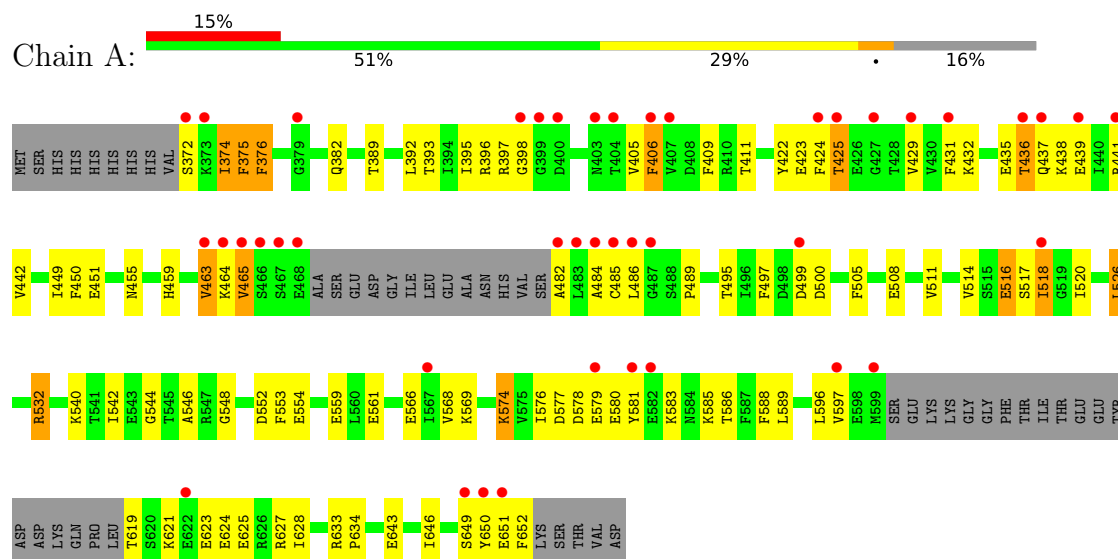
- Molecule 3 is water.

Mol	Chain	Residues	Atoms		ZeroOcc	AltConf
3	A	12	Total	O	0	0
			12	12		

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: Sodium/calcium exchanger 1



4 Data and refinement statistics

Property	Value	Source
Space group	C 2 2 21	Depositor
Cell constants a, b, c, α , β , γ	80.67Å 152.55Å 79.70Å 90.00° 90.00° 90.00°	Depositor
Resolution (Å)	43.02 – 2.68 43.02 – 2.68	Depositor EDS
% Data completeness (in resolution range)	80.1 (43.02-2.68) 80.1 (43.02-2.68)	Depositor EDS
R_{merge}	0.08	Depositor
R_{sym}	(Not available)	Depositor
$\langle I/\sigma(I) \rangle$ ¹	1.43 (at 2.69Å)	Xtriage
Refinement program	PHENIX (phenix.refine: 1.7_650)	Depositor
R, R_{free}	0.234 , 0.274 0.240 , 0.285	Depositor DCC
R_{free} test set	899 reflections (5.78%)	wwPDB-VP
Wilson B-factor (Å ²)	66.8	Xtriage
Anisotropy	0.044	Xtriage
Bulk solvent k_{sol} (e/Å ³), B_{sol} (Å ²)	0.32 , 82.3	EDS
L-test for twinning ²	$\langle L \rangle = 0.48$, $\langle L^2 \rangle = 0.32$	Xtriage
Estimated twinning fraction	No twinning to report.	Xtriage
F_o, F_c correlation	0.91	EDS
Total number of atoms	1905	wwPDB-VP
Average B, all atoms (Å ²)	84.0	wwPDB-VP

Xtriage's analysis on translational NCS is as follows: *The largest off-origin peak in the Patterson function is 5.31% 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: 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	0.32	0/1917	0.87	4/2588 (0.2%)

There are no bond length outliers.

All (4) bond angle outliers are listed below:

Mol	Chain	Res	Type	Atoms	Z	Observed(°)	Ideal(°)
1	A	425	THR	N-CA-C	13.28	129.72	111.39
1	A	424	PHE	N-CA-C	10.91	123.18	111.28
1	A	375	PHE	N-CA-C	6.25	116.32	108.45
1	A	579	GLU	N-CA-C	-5.07	107.16	113.19

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	1890	0	1761	94	0
2	A	3	0	0	0	0
3	A	12	0	0	0	0
All	All	1905	0	1761	94	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 26.

All (94) 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:484:ALA:HB1	1:A:485:CYS:HA	1.28	1.10
1:A:425:THR:HG21	1:A:442:VAL:HG22	1.39	1.00
1:A:517:SER:O	1:A:518:ILE:HG23	1.62	0.99
1:A:517:SER:O	1:A:518:ILE:HG12	1.62	0.97
1:A:649:SER:CB	1:A:650:TYR:HA	1.97	0.94
1:A:464:LYS:HA	1:A:465:VAL:CB	2.03	0.87
1:A:517:SER:C	1:A:518:ILE:HG23	1.99	0.85
1:A:484:ALA:HB1	1:A:485:CYS:CA	2.06	0.85
1:A:393:THR:HG22	1:A:439:GLU:HG2	1.58	0.84
1:A:499:ASP:O	1:A:532:ARG:NH1	2.14	0.81
1:A:517:SER:O	1:A:518:ILE:CG1	2.32	0.78
1:A:517:SER:O	1:A:518:ILE:CG2	2.32	0.78
1:A:406:PHE:CG	1:A:464:LYS:HE3	2.21	0.75
1:A:651:GLU:O	1:A:652:PHE:CD2	2.40	0.75
1:A:395:ILE:HG22	1:A:437:GLN:OE1	1.87	0.74
1:A:484:ALA:CB	1:A:485:CYS:HA	2.09	0.74
1:A:405:VAL:O	1:A:431:PHE:HD2	1.71	0.73
1:A:396:ARG:HG3	1:A:436:THR:HG22	1.70	0.73
1:A:405:VAL:C	1:A:406:PHE:CD2	2.68	0.72
1:A:405:VAL:C	1:A:406:PHE:HD2	1.98	0.70
1:A:396:ARG:HG3	1:A:436:THR:CG2	2.21	0.69
1:A:406:PHE:HD2	1:A:406:PHE:N	1.90	0.68
1:A:455:ASN:HD22	1:A:495:THR:HA	1.59	0.68
1:A:578:ASP:C	1:A:580:GLU:H	1.99	0.68
1:A:583:LYS:H	1:A:585:LYS:HZ2	1.42	0.67
1:A:405:VAL:O	1:A:431:PHE:CD2	2.48	0.66
1:A:375:PHE:CE1	1:A:395:ILE:HD11	2.33	0.64
1:A:505:PHE:HA	1:A:526:LEU:O	1.98	0.64
1:A:464:LYS:CA	1:A:465:VAL:CB	2.75	0.62
1:A:583:LYS:H	1:A:585:LYS:NZ	1.97	0.62
1:A:425:THR:HG22	1:A:425:THR:O	2.00	0.62
1:A:425:THR:CG2	1:A:442:VAL:HG22	2.23	0.62
1:A:546:ALA:HB2	1:A:585:LYS:HB3	1.83	0.61
1:A:517:SER:O	1:A:518:ILE:CB	2.48	0.61
1:A:372:SER:HB3	1:A:398:GLY:O	2.01	0.60
1:A:517:SER:C	1:A:518:ILE:CG2	2.71	0.60
1:A:374:ILE:HG21	1:A:463:VAL:HG11	1.85	0.59
1:A:393:THR:CG2	1:A:439:GLU:HG2	2.30	0.59
1:A:432:LYS:N	1:A:435:GLU:OE2	2.36	0.59
1:A:389:THR:HG21	1:A:441:ARG:NH2	2.17	0.59

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Atom-1	Atom-2	Interatomic distance (Å)	Clash overlap (Å)
1:A:455:ASN:ND2	1:A:495:THR:HA	2.18	0.59
1:A:465:VAL:HA	1:A:482:ALA:N	2.18	0.59
1:A:406:PHE:CD2	1:A:406:PHE:N	2.61	0.58
1:A:449:ILE:O	1:A:451:GLU:HG3	2.02	0.58
1:A:431:PHE:CE1	1:A:438:LYS:HG2	2.41	0.56
1:A:585:LYS:N	1:A:585:LYS:HD2	2.19	0.56
1:A:409:PHE:HE1	1:A:425:THR:HG22	1.70	0.56
1:A:484:ALA:CB	1:A:485:CYS:CA	2.77	0.55
1:A:425:THR:HG21	1:A:442:VAL:CG2	2.27	0.55
1:A:578:ASP:C	1:A:580:GLU:N	2.64	0.54
1:A:520:ILE:HG22	1:A:574:LYS:HG2	1.89	0.54
1:A:561:GLU:O	1:A:569:LYS:HE2	2.07	0.53
1:A:406:PHE:HB2	1:A:464:LYS:HE3	1.91	0.52
1:A:651:GLU:O	1:A:652:PHE:CB	2.57	0.52
1:A:651:GLU:O	1:A:652:PHE:CG	2.63	0.51
1:A:425:THR:OG1	1:A:442:VAL:HG13	2.11	0.51
1:A:382:GLN:HG2	1:A:495:THR:HB	1.91	0.51
1:A:375:PHE:CZ	1:A:395:ILE:HD11	2.46	0.51
1:A:552:ASP:O	1:A:576:ILE:HG12	2.11	0.50
1:A:382:GLN:HB3	1:A:497:PHE:HE2	1.77	0.50
1:A:624:GLU:O	1:A:628:ILE:HG13	2.11	0.50
1:A:406:PHE:HA	1:A:429:VAL:O	2.12	0.50
1:A:376:PHE:HB2	1:A:489:PRO:O	2.13	0.49
1:A:409:PHE:HA	1:A:459:HIS:O	2.13	0.49
1:A:406:PHE:CB	1:A:464:LYS:HE3	2.43	0.48
1:A:406:PHE:CD2	1:A:464:LYS:HE3	2.48	0.48
1:A:396:ARG:HG3	1:A:436:THR:HG23	1.96	0.48
1:A:649:SER:CB	1:A:650:TYR:CA	2.78	0.46
1:A:406:PHE:HB3	1:A:429:VAL:O	2.15	0.46
1:A:511:VAL:HG22	1:A:643:GLU:HB3	1.98	0.46
1:A:464:LYS:HB2	1:A:465:VAL:C	2.40	0.46
1:A:514:VAL:O	1:A:646:ILE:HA	2.17	0.45
1:A:554:GLU:HB2	1:A:574:LYS:HB2	1.99	0.45
1:A:396:ARG:NH2	1:A:435:GLU:O	2.50	0.44
1:A:623:GLU:O	1:A:627:ARG:HG3	2.17	0.44
1:A:450:PHE:HA	1:A:500:ASP:HB2	2.00	0.44
1:A:542:ILE:HB	1:A:588:PHE:HB2	2.00	0.43
1:A:651:GLU:O	1:A:652:PHE:HB2	2.18	0.43
1:A:406:PHE:HB2	1:A:464:LYS:CE	2.49	0.42
1:A:633:ARG:HB2	1:A:634:PRO:HD2	2.01	0.42
1:A:516:GLU:H	1:A:516:GLU:HG3	1.62	0.42

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Atom-1	Atom-2	Interatomic distance (Å)	Clash overlap (Å)
1:A:548:GLY:HA2	1:A:553:PHE:O	2.19	0.42
1:A:422:TYR:HD1	1:A:423:GLU:O	2.04	0.41
1:A:508:GLU:CG	1:A:526:LEU:HD13	2.50	0.41
1:A:544:GLY:HA3	1:A:586:THR:O	2.19	0.41
1:A:621:LYS:O	1:A:625:GLU:HG3	2.21	0.41
1:A:566:GLU:CD	1:A:569:LYS:NZ	2.79	0.41
1:A:374:ILE:O	1:A:374:ILE:HG23	2.21	0.41
1:A:455:ASN:HD21	1:A:495:THR:HG23	1.86	0.41
1:A:374:ILE:O	1:A:486:LEU:O	2.39	0.41
1:A:437:GLN:O	1:A:438:LYS:HD2	2.21	0.41
1:A:411:THR:HG23	1:A:425:THR:HB	2.02	0.41
1:A:392:LEU:HD12	1:A:392:LEU:N	2.37	0.40
1:A:540:LYS:O	1:A:589:LEU:HD12	2.21	0.40

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	243/295 (82%)	221 (91%)	19 (8%)	3 (1%)	10	24

All (3) Ramachandran outliers are listed below:

Mol	Chain	Res	Type
1	A	518	ILE
1	A	465	VAL
1	A	581	TYR

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	198/258 (77%)	182 (92%)	16 (8%)	11	25

All (16) residues with a non-rotameric sidechain are listed below:

Mol	Chain	Res	Type
1	A	374	ILE
1	A	376	PHE
1	A	397	ARG
1	A	406	PHE
1	A	436	THR
1	A	463	VAL
1	A	516	GLU
1	A	526	LEU
1	A	532	ARG
1	A	559	GLU
1	A	568	VAL
1	A	574	LYS
1	A	577	ASP
1	A	596	LEU
1	A	597	VAL
1	A	619	THR

Sometimes sidechains can be flipped to improve hydrogen bonding and reduce clashes. All (2) such sidechains are listed below:

Mol	Chain	Res	Type
1	A	455	ASN
1	A	563	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 3 ligands modelled in this entry, 3 are 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, 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	249/295 (84%)	1.04	43 (17%) 4 3	38, 78, 160, 220	0

All (43) RSRZ outliers are listed below:

Mol	Chain	Res	Type	RSRZ
1	A	464	LYS	7.7
1	A	579	GLU	7.1
1	A	465	VAL	7.0
1	A	425	THR	6.9
1	A	467	SER	5.8
1	A	406	PHE	5.7
1	A	482	ALA	5.7
1	A	483	LEU	5.5
1	A	581	TYR	4.5
1	A	486	LEU	4.5
1	A	424	PHE	4.0
1	A	484	ALA	3.9
1	A	651	GLU	3.9
1	A	650	TYR	3.8
1	A	649	SER	3.8
1	A	399	GLY	3.7
1	A	404	THR	3.6
1	A	431	PHE	3.6
1	A	429	VAL	3.4
1	A	468	GLU	3.3
1	A	582	GLU	3.3
1	A	427	GLY	3.2
1	A	485	CYS	3.1
1	A	599	MET	3.1
1	A	398	GLY	2.9
1	A	436	THR	2.9
1	A	372	SER	2.9

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Mol	Chain	Res	Type	RSRZ
1	A	466	SER	2.8
1	A	437	GLN	2.7
1	A	518	ILE	2.7
1	A	439	GLU	2.6
1	A	403	ASN	2.4
1	A	567	ILE	2.4
1	A	407	VAL	2.4
1	A	499	ASP	2.4
1	A	379	GLY	2.3
1	A	400	ASP	2.3
1	A	441	ARG	2.3
1	A	373	LYS	2.2
1	A	487	GLY	2.2
1	A	622	GLU	2.1
1	A	463	VAL	2.1
1	A	597	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
2	CA	A	2	1/1	0.86	0.16	61,61,61,61	0
2	CA	A	1	1/1	0.94	0.22	69,69,69,69	0
2	CA	A	3	1/1	0.94	0.08	45,45,45,45	0

6.5 Other polymers [i](#)

There are no such residues in this entry.