



Full wwPDB X-ray Structure Validation Report ⓘ

Mar 6, 2026 – 08:27 PM UTC

PDB ID : 2W70 / pdb_00002w70
Title : Crystal structure of Biotin carboxylase from E. coli in complex with the amin
o-thiazole-pyrimidine fragment
Authors : Mochalkin, I.; Miller, J.R.
Deposited on : 2008-12-19
Resolution : 1.77 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

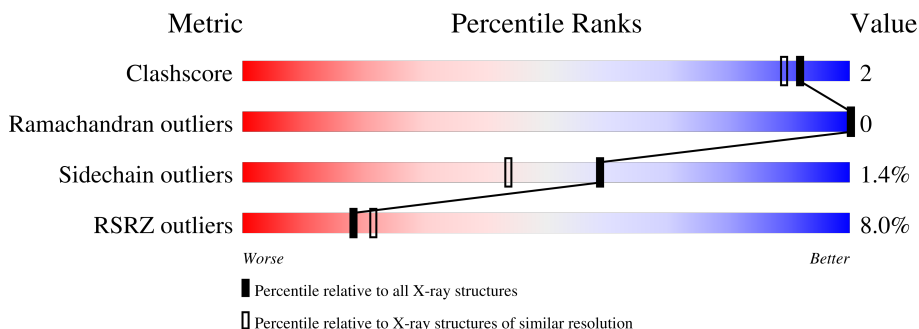
1 Overall quality at a glance

The following experimental techniques were used to determine the structure:

X-RAY DIFFRACTION

The reported resolution of this entry is 1.77 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	190562	1395 (1.78-1.78)
Ramachandran outliers	187476	1382 (1.78-1.78)
Sidechain outliers	187428	1382 (1.78-1.78)
RSRZ outliers	180081	1365 (1.78-1.78)

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	449	3% 96% ..
1	B	449	13% 94% 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
2	L22	A	1447	-	X	-	-
2	L22	B	1447	-	X	-	-

2 Entry composition [i](#)

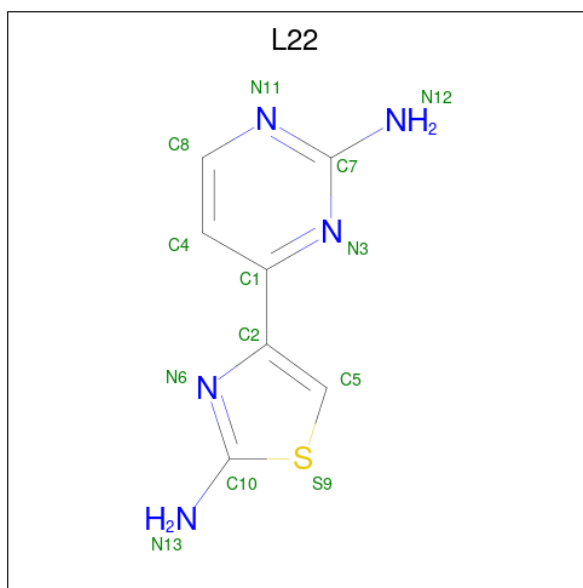
There are 4 unique types of molecules in this entry. The entry contains 7863 atoms, of which 0 are hydrogens and 0 are deuteriums.

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 BIOTIN CARBOXYLASE.

Mol	Chain	Residues	Atoms					ZeroOcc	AltConf	Trace
1	A	446	Total	C	N	O	S	0	4	0
			3444	2170	614	638	22			
1	B	446	Total	C	N	O	S	0	4	0
			3449	2172	617	638	22			

- Molecule 2 is 4-(2-amino-1,3-thiazol-4-yl)pyrimidin-2-amine (CCD ID: L22) (formula: $C_7H_7N_5S$).



Mol	Chain	Residues	Atoms				ZeroOcc	AltConf
2	A	1	Total	C	N	S	0	0
			13	7	5	1		
2	B	1	Total	C	N	S	0	0
			13	7	5	1		

- Molecule 3 is CHLORIDE ION (CCD ID: CL) (formula: Cl).

Mol	Chain	Residues	Atoms		ZeroOcc	AltConf
3	A	1	Total 1	Cl 1	0	0
3	B	1	Total 1	Cl 1	0	0

- Molecule 4 is water.

Mol	Chain	Residues	Atoms		ZeroOcc	AltConf
4	A	538	Total 538	O 538	0	0
4	B	404	Total 404	O 404	0	0

3 Residue-property plots [i](#)

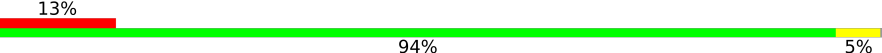
These plots are drawn for all protein, RNA, DNA and oligosaccharide chains in the entry. The first graphic for a chain summarises the proportions of the various outlier classes displayed in the second graphic. The second graphic shows the sequence view annotated by issues in geometry and electron density. 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.

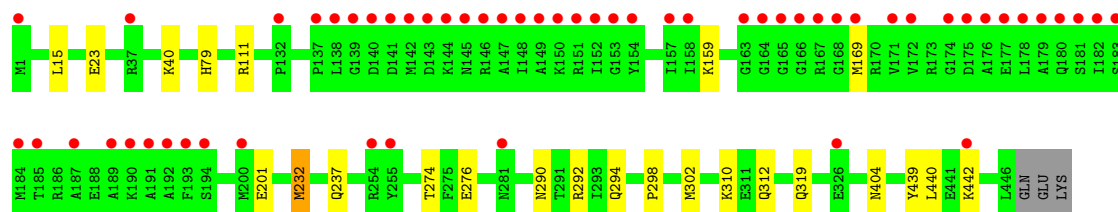
• Molecule 1: BIOTIN CARBOXYLASE

Chain A: 



• Molecule 1: BIOTIN CARBOXYLASE

Chain B: 



4 Data and refinement statistics

Property	Value	Source
Space group	P 21 21 21	Depositor
Cell constants a, b, c, α , β , γ	84.23Å 106.22Å 122.64Å 90.00° 90.00° 90.00°	Depositor
Resolution (Å)	20.00 – 1.77 20.00 – 1.77	Depositor EDS
% Data completeness (in resolution range)	99.8 (20.00-1.77) 93.5 (20.00-1.77)	Depositor EDS
R_{merge}	0.08	Depositor
R_{sym}	(Not available)	Depositor
$\langle I/\sigma(I) \rangle$ ¹	2.32 (at 1.77Å)	Xtriage
Refinement program	REFMAC 5.2.0005	Depositor
R, R_{free}	0.174 , 0.202 0.192 , (Not available)	Depositor DCC
R_{free} test set	No test flags present.	wwPDB-VP
Wilson B-factor (Å ²)	18.1	Xtriage
Anisotropy	0.289	Xtriage
Bulk solvent k_{sol} (e/Å ³), B_{sol} (Å ²)	0.35 , 39.5	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	0.95	EDS
Total number of atoms	7863	wwPDB-VP
Average B, all atoms (Å ²)	24.0	wwPDB-VP

Xtriage's analysis on translational NCS is as follows: *The largest off-origin peak in the Patterson function is 4.91% 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: L22, CL

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	0.52	0/3527	0.69	0/4759
1	B	0.51	0/3532	0.70	0/4766
All	All	0.51	0/7059	0.69	0/9525

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	2	0

There are no bond length outliers.

There are no bond angle outliers.

All (2) chirality outliers are listed below:

Mol	Chain	Res	Type	Atom
1	A	72[A]	ILE	CB
1	A	72[B]	ILE	CB

There are no planarity outliers.

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	3444	0	3476	5	0
1	B	3449	0	3479	17	0
2	A	13	0	7	0	0
2	B	13	0	7	0	0
3	A	1	0	0	0	0
3	B	1	0	0	1	0
4	A	538	0	0	0	0
4	B	404	0	0	3	0
All	All	7863	0	6969	22	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 2.

All (22) 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:B:232:MET:HE2	1:B:440:LEU:HB2	1.52	0.92
1:B:232:MET:HE3	1:B:232:MET:HA	1.63	0.80
1:A:79:HIS:HD1	1:A:81:GLY:H	1.38	0.69
1:B:232:MET:HA	1:B:232:MET:CE	2.31	0.57
1:A:340:ASN:HD22	1:A:384:MET:HA	1.70	0.56
1:B:276:GLU:CD	1:B:290:ASN:HD21	2.14	0.56
1:B:292:ARG:NH1	3:B:1448:CL:CL	2.76	0.55
1:B:232:MET:HE1	1:B:439:TYR:HB3	1.89	0.55
1:A:186:ARG:HG2	1:A:196:ASP:HB2	1.90	0.53
1:B:159:LYS:HE2	1:B:169:MET:HE3	1.92	0.51
1:B:232:MET:HE2	1:B:440:LEU:CB	2.31	0.51
1:B:79:HIS:HE2	1:B:312:GLN:NE2	2.09	0.50
1:B:298:PRO:O	1:B:302:MET:HG2	2.13	0.47
1:B:232:MET:HE3	4:B:2390:HOH:O	2.13	0.47
1:B:319:GLN:NE2	4:B:2259:HOH:O	2.48	0.46
1:B:274:THR:HG21	1:B:294:GLN:HE22	1.81	0.46
1:B:23:GLU:OE1	1:B:310:LYS:NZ	2.40	0.46
1:B:15:LEU:CD2	1:B:40:LYS:HD2	2.48	0.44
1:A:298:PRO:O	1:A:302:MET:HG2	2.19	0.43
1:A:297:HIS:N	1:A:298:PRO:CD	2.83	0.41
1:B:15:LEU:HD22	1:B:40:LYS:HD2	2.02	0.41
1:B:404:ASN:ND2	4:B:2351:HOH:O	2.50	0.41

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	448/449 (100%)	440 (98%)	8 (2%)	0	100	100
1	B	448/449 (100%)	436 (97%)	12 (3%)	0	100	100
All	All	896/898 (100%)	876 (98%)	20 (2%)	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	A	362/361 (100%)	356 (98%)	6 (2%)	53	36
1	B	362/361 (100%)	356 (98%)	6 (2%)	53	36
All	All	724/722 (100%)	712 (98%)	12 (2%)	59	36

All (12) residues with a non-rotameric sidechain are listed below:

Mol	Chain	Res	Type
1	A	106	LYS
1	A	235	ARG
1	A	237	GLN
1	A	323	ILE
1	A	382[A]	ASP
1	A	382[B]	ASP
1	B	111	ARG
1	B	201	GLU

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Mol	Chain	Res	Type
1	B	232	MET
1	B	237[A]	GLN
1	B	237[B]	GLN
1	B	442	LYS

Sometimes sidechains can be flipped to improve hydrogen bonding and reduce clashes. All (16) such sidechains are listed below:

Mol	Chain	Res	Type
1	A	94	GLN
1	A	237	GLN
1	A	312	GLN
1	A	319	GLN
1	A	340	ASN
1	A	404	ASN
1	A	426	ASN
1	A	431	GLN
1	B	233	GLN
1	B	290	ASN
1	B	294	GLN
1	B	312	GLN
1	B	319	GLN
1	B	345	ASN
1	B	358	HIS
1	B	404	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 4 ligands modelled in this entry, 2 are monoatomic - leaving 2 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	L22	B	1447	-	14,14,14	1.26	2 (14%)	17,19,19	2.81	11 (64%)
2	L22	A	1447	-	14,14,14	1.19	2 (14%)	17,19,19	2.92	11 (64%)

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	L22	B	1447	-	-	4/4/4/4	0/2/2/2
2	L22	A	1447	-	-	4/4/4/4	0/2/2/2

All (4) bond length outliers are listed below:

Mol	Chain	Res	Type	Atoms	Z	Observed(Å)	Ideal(Å)
2	B	1447	L22	C10-N6	3.01	1.36	1.31
2	A	1447	L22	C10-N6	2.82	1.35	1.31
2	A	1447	L22	C5-C2	2.74	1.39	1.36
2	B	1447	L22	C5-C2	2.69	1.39	1.36

All (22) bond angle outliers are listed below:

Mol	Chain	Res	Type	Atoms	Z	Observed(°)	Ideal(°)
2	B	1447	L22	C1-N3-C7	5.27	120.26	116.37
2	A	1447	L22	C1-N3-C7	5.11	120.14	116.37
2	A	1447	L22	C8-N11-C7	4.73	120.92	116.21
2	A	1447	L22	N11-C7-N3	-4.55	120.63	125.70
2	A	1447	L22	C5-S9-C10	4.35	90.72	88.84
2	B	1447	L22	N11-C7-N3	-4.07	121.17	125.70
2	B	1447	L22	C8-N11-C7	4.06	120.25	116.21

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Mol	Chain	Res	Type	Atoms	Z	Observed(°)	Ideal(°)
2	A	1447	L22	C4-C8-N11	-3.31	119.92	123.97
2	B	1447	L22	C8-C4-C1	3.26	119.03	117.02
2	B	1447	L22	C2-C1-N3	3.26	119.58	115.59
2	B	1447	L22	C4-C1-N3	-3.19	119.20	122.92
2	B	1447	L22	C4-C8-N11	-3.17	120.09	123.97
2	B	1447	L22	C10-N6-C2	2.89	112.20	110.62
2	A	1447	L22	C4-C1-N3	-2.73	119.73	122.92
2	B	1447	L22	C5-S9-C10	2.70	90.01	88.84
2	A	1447	L22	C8-C4-C1	2.67	118.66	117.02
2	A	1447	L22	C2-C1-N3	2.60	118.77	115.59
2	A	1447	L22	C10-N6-C2	2.59	112.03	110.62
2	A	1447	L22	S9-C10-N6	-2.30	112.72	114.54
2	A	1447	L22	N12-C7-N11	2.28	119.76	117.40
2	B	1447	L22	S9-C10-N13	2.27	123.63	120.99
2	B	1447	L22	S9-C10-N6	-2.18	112.82	114.54

There are no chirality outliers.

All (8) torsion outliers are listed below:

Mol	Chain	Res	Type	Atoms
2	B	1447	L22	C4-C1-C2-C5
2	B	1447	L22	C4-C1-C2-N6
2	B	1447	L22	N3-C1-C2-C5
2	B	1447	L22	N3-C1-C2-N6
2	A	1447	L22	C4-C1-C2-C5
2	A	1447	L22	C4-C1-C2-N6
2	A	1447	L22	N3-C1-C2-C5
2	A	1447	L22	N3-C1-C2-N6

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	446/449 (99%)	0.14	14 (3%) 51 59	15, 21, 28, 36	4 (0%)
1	B	446/449 (99%)	0.62	57 (12%) 7 8	14, 21, 57, 60	4 (0%)
All	All	892/898 (99%)	0.38	71 (7%) 18 21	14, 21, 46, 60	8 (0%)

All (71) RSRZ outliers are listed below:

Mol	Chain	Res	Type	RSRZ
1	B	168	GLY	7.1
1	B	178	LEU	4.8
1	B	182	ILE	4.6
1	B	142	MET	4.5
1	B	193	PHE	4.5
1	B	143	ASP	4.5
1	B	167	ARG	4.3
1	B	166	GLY	4.3
1	B	146	ARG	4.2
1	B	194	SER	4.1
1	B	192	ALA	4.1
1	B	172	VAL	4.1
1	B	147	ALA	4.0
1	B	150	LYS	4.0
1	B	165	GLY	3.9
1	B	148	ILE	3.8
1	B	152	ILE	3.8
1	B	181	SER	3.8
1	A	193	PHE	3.7
1	B	180	GLN	3.6
1	B	154	TYR	3.6
1	B	185	THR	3.6
1	B	254	ARG	3.5
1	B	176	ALA	3.5

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Mol	Chain	Res	Type	RSRZ
1	B	187	ALA	3.4
1	B	179	ALA	3.4
1	B	189	ALA	3.4
1	B	174	GLY	3.3
1	B	171	VAL	3.3
1	B	164	GLY	3.3
1	B	200	MET	3.1
1	B	157	ILE	3.1
1	B	141	ASP	3.0
1	B	37	ARG	2.9
1	A	446	LEU	2.9
1	B	184	MET	2.8
1	A	445	GLY	2.8
1	B	169	MET	2.8
1	B	140	ASP	2.8
1	B	1	MET	2.7
1	B	158	ILE	2.7
1	A	326	GLU	2.6
1	B	175	ASP	2.6
1	B	281	ASN	2.6
1	A	164	GLY	2.6
1	B	163	GLY	2.6
1	B	139	GLY	2.5
1	A	40	LYS	2.5
1	A	97	ARG	2.4
1	B	151	ARG	2.4
1	A	96	GLU	2.4
1	B	144	LYS	2.4
1	B	177	GLU	2.4
1	B	153	GLY	2.3
1	B	132	PRO	2.3
1	B	326	GLU	2.3
1	B	255	TYR	2.3
1	A	167	ARG	2.3
1	B	145	ASN	2.3
1	A	1	MET	2.3
1	B	149	ALA	2.3
1	B	191	ALA	2.3
1	B	190	LYS	2.2
1	A	165	GLY	2.2
1	B	442	LYS	2.2
1	A	346	THR	2.2

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Mol	Chain	Res	Type	RSRZ
1	B	137	PRO	2.2
1	B	138	LEU	2.2
1	A	331	ARG	2.2
1	A	166	GLY	2.0
1	B	183	SER	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	L22	B	1447	13/13	0.88	0.11	35,36,37,39	0
2	L22	A	1447	13/13	0.94	0.07	20,22,25,29	0
3	CL	B	1448	1/1	0.98	0.10	21,21,21,21	0
3	CL	A	1448	1/1	1.00	0.05	17,17,17,17	0

6.5 Other polymers [i](#)

There are no such residues in this entry.