



Full wwPDB X-ray Structure Validation Report ⓘ

Mar 6, 2026 – 07:04 PM UTC

PDB ID : 1KV7 / pdb_00001kv7
Title : Crystal Structure of CueO, a multi-copper oxidase from E. coli involved in copper homeostasis
Authors : Roberts, S.A.; Weichsel, A.; Grass, G.; Thakali, K.; Hazzard, J.T.; Tollin, G.; Rensing, C.; Montfort, W.R.
Deposited on : 2002-01-25
Resolution : 1.40 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

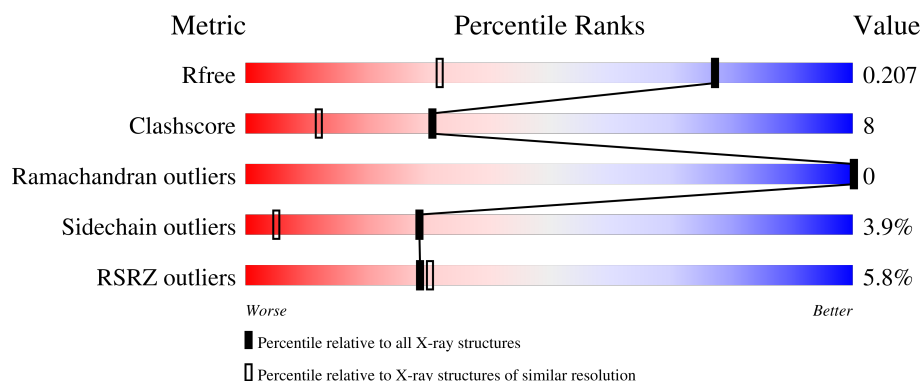
1 Overall quality at a glance

The following experimental techniques were used to determine the structure:

X-RAY DIFFRACTION

The reported resolution of this entry is 1.40 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	2563 (1.40-1.40)
Clashscore	190562	2660 (1.40-1.40)
Ramachandran outliers	187476	2611 (1.40-1.40)
Sidechain outliers	187428	2610 (1.40-1.40)
RSRZ outliers	180081	2561 (1.40-1.40)

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	488	6% 76% 17% • 5%

2 Entry composition [i](#)

There are 4 unique types of molecules in this entry. The entry contains 4073 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.

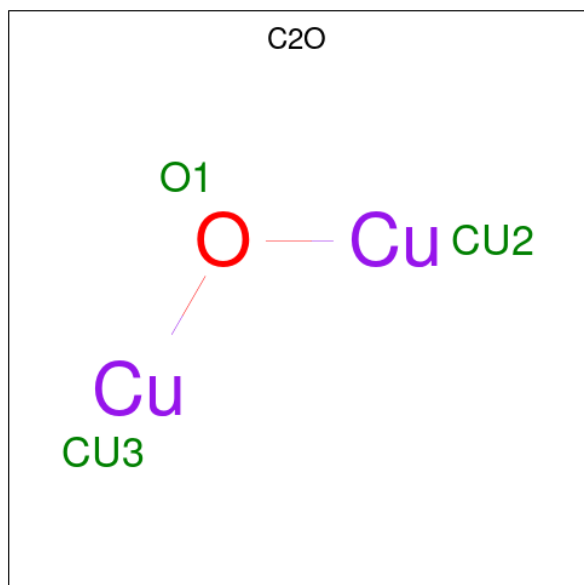
- Molecule 1 is a protein called PROBABLE BLUE-COPPER PROTEIN YACK.

Mol	Chain	Residues	Atoms					ZeroOcc	AltConf	Trace
			Total	C	N	O	S			
1	A	463	3561	2261	619	654	27	0	3	0

- Molecule 2 is COPPER (II) ION (CCD ID: CU) (formula: Cu).

Mol	Chain	Residues	Atoms		ZeroOcc	AltConf
2	A	2	Total	Cu	0	0
			2	2		

- Molecule 3 is CU-O-CU LINKAGE (CCD ID: C2O) (formula: Cu₂O).



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

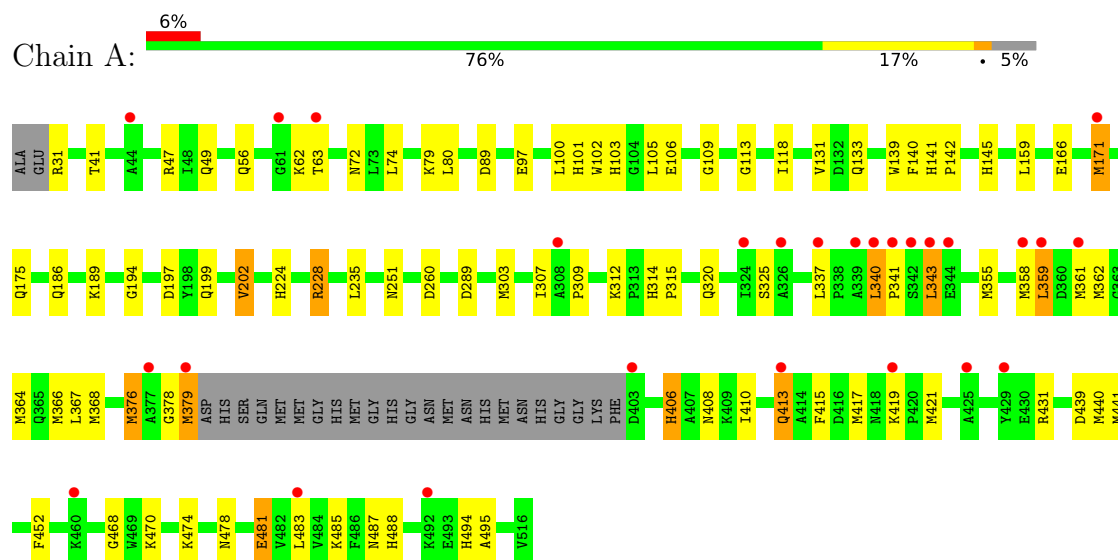
- Molecule 4 is water.

Mol	Chain	Residues	Atoms		ZeroOcc	AltConf
4	A	507	Total 507	O 507	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: PROBABLE BLUE-COPPER PROTEIN YACK



4 Data and refinement statistics

Property	Value	Source
Space group	P 1 21 1	Depositor
Cell constants a, b, c, α , β , γ	49.82Å 90.51Å 53.09Å 90.00° 102.90° 90.00°	Depositor
Resolution (Å)	26.00 – 1.40 26.00 – 1.40	Depositor EDS
% Data completeness (in resolution range)	(Not available) (26.00-1.40) 97.9 (26.00-1.40)	Depositor EDS
R_{merge}	(Not available)	Depositor
R_{sym}	0.06	Depositor
$\langle I/\sigma(I) \rangle$ ¹	2.96 (at 1.40Å)	Xtriage
Refinement program	SHELXL-97	Depositor
R, R_{free}	0.185 , 0.221 0.175 , 0.207	Depositor DCC
R_{free} test set	4484 reflections (5.09%)	wwPDB-VP
Wilson B-factor (Å ²)	12.6	Xtriage
Anisotropy	0.255	Xtriage
Bulk solvent k_{sol} (e/Å ³), B_{sol} (Å ²)	0.34 , 46.2	EDS
L-test for twinning ²	$\langle L \rangle = 0.51$, $\langle L^2 \rangle = 0.34$	Xtriage
Estimated twinning fraction	No twinning to report.	Xtriage
F_o, F_c correlation	0.97	EDS
Total number of atoms	4073	wwPDB-VP
Average B, all atoms (Å ²)	20.0	wwPDB-VP

Xtriage's analysis on translational NCS is as follows: *The largest off-origin peak in the Patterson function is 7.14% 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: C2O, CU

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	0.72	0/3664	1.56	29/4976 (0.6%)

There are no bond length outliers.

All (29) bond angle outliers are listed below:

Mol	Chain	Res	Type	Atoms	Z	Observed(°)	Ideal(°)
1	A	378	GLY	CA-C-O	-30.58	85.08	119.02
1	A	378	GLY	O-C-N	24.03	152.90	122.39
1	A	228	ARG	CD-NE-CZ	18.23	149.93	124.40
1	A	452	PHE	CA-CB-CG	7.61	121.41	113.80
1	A	474	LYS	O-C-N	6.71	131.19	122.93
1	A	406	HIS	CA-C-O	6.17	127.81	120.53
1	A	197	ASP	CA-CB-CG	6.04	118.64	112.60
1	A	235	LEU	O-C-N	5.91	129.95	123.04
1	A	495	ALA	O-C-N	5.85	129.52	122.85
1	A	109	GLY	O-C-N	-5.78	116.11	122.24
1	A	109	GLY	CA-C-O	5.58	126.42	120.40
1	A	260	ASP	O-C-N	5.43	127.88	122.12
1	A	103	HIS	CE1-NE2-CD2	-5.42	103.58	109.00
1	A	307	ILE	CA-C-O	-5.42	114.67	120.85
1	A	72	ASN	OD1-CG-ND2	5.39	127.99	122.60
1	A	171	MET	CA-C-O	5.39	127.04	120.57
1	A	495	ALA	CA-C-O	-5.39	115.45	121.81
1	A	228	ARG	NE-CZ-NH1	5.38	126.88	121.50
1	A	415	PHE	O-C-N	5.36	129.11	123.11
1	A	139	TRP	CA-C-O	-5.34	115.70	121.36
1	A	140	PHE	CA-CB-CG	5.33	119.13	113.80
1	A	224	HIS	CA-CB-CG	-5.27	108.53	113.80
1	A	101	HIS	CA-C-O	-5.20	115.20	120.71
1	A	103	HIS	ND1-CE1-NE2	5.18	113.58	108.40

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Mol	Chain	Res	Type	Atoms	Z	Observed(°)	Ideal(°)
1	A	159	LEU	CA-C-O	-5.17	115.41	121.46
1	A	478	ASN	CA-C-O	-5.12	115.67	121.05
1	A	481	GLU	O-C-N	5.09	129.27	123.31
1	A	103	HIS	CG-CD2-NE2	5.05	112.25	107.20
1	A	410	ILE	O-C-N	5.03	128.63	123.20

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	3561	0	3541	59	0
2	A	2	0	0	0	0
3	A	3	0	0	0	0
4	A	507	0	0	21	0
All	All	4073	0	3541	59	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 8.

All (59) 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:431:ARG:HD2	1:A:481:GLU:OE2	1.83	0.78
1:A:251:ASN:HA	4:A:2294:HOH:O	1.83	0.77
1:A:202:VAL:HG12	4:A:2193:HOH:O	1.86	0.75
1:A:79:LYS:HG2	4:A:2423:HOH:O	1.86	0.74
1:A:106:GLU:H	1:A:133:GLN:HE22	1.33	0.73
1:A:340:LEU:HD22	4:A:2415:HOH:O	1.90	0.70
1:A:303[B]:MET:HE1	1:A:364:MET:HG2	1.74	0.69
1:A:106:GLU:H	1:A:133:GLN:NE2	1.91	0.69
1:A:228:ARG:HD3	1:A:289:ASP:OD1	1.94	0.68
1:A:379:MET:O	1:A:379:MET:HE3	1.96	0.66
1:A:413:GLN:NE2	1:A:421:MET:HE2	2.11	0.65

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Atom-1	Atom-2	Interatomic distance (Å)	Clash overlap (Å)
1:A:320:GLN:HG3	4:A:2232:HOH:O	1.98	0.64
1:A:303[B]:MET:SD	1:A:376:MET:HE1	2.37	0.63
1:A:97:GLU:OE1	1:A:118:ILE:HD12	1.99	0.63
1:A:41:THR:HB	4:A:2448:HOH:O	2.01	0.60
1:A:303[A]:MET:SD	1:A:364:MET:HG2	2.42	0.59
1:A:145:HIS:HB3	4:A:2424:HOH:O	2.03	0.58
1:A:56:GLN:OE1	1:A:63:THR:HG22	2.05	0.56
1:A:366:MET:HE1	4:A:2445:HOH:O	2.05	0.56
1:A:485:LYS:NZ	1:A:487:ASN:HD21	2.03	0.56
1:A:494:HIS:HE1	4:A:2490:HOH:O	1.87	0.56
1:A:202:VAL:HG13	1:A:366:MET:SD	2.46	0.56
1:A:80:LEU:HB3	1:A:131:VAL:HG21	1.88	0.55
1:A:337:LEU:HD13	4:A:2295:HOH:O	2.06	0.55
1:A:202:VAL:HG23	1:A:359:LEU:HD23	1.88	0.55
1:A:303[B]:MET:HE1	1:A:441:MET:HE1	1.88	0.55
1:A:337:LEU:HD21	1:A:468:GLY:HA2	1.88	0.55
1:A:171:MET:HB3	4:A:2307:HOH:O	2.09	0.53
1:A:362:MET:O	1:A:366:MET:HG3	2.08	0.53
1:A:485:LYS:HZ3	1:A:487:ASN:HD21	1.57	0.52
1:A:309:PRO:HB2	4:A:2396:HOH:O	2.09	0.52
1:A:166:GLU:HB2	4:A:2403:HOH:O	2.12	0.50
1:A:303[B]:MET:HE2	1:A:441:MET:SD	2.51	0.50
1:A:314:HIS:HE1	4:A:2214:HOH:O	1.94	0.49
1:A:303[A]:MET:HG2	1:A:367:LEU:CD2	2.42	0.49
1:A:102:TRP:HB3	1:A:105:LEU:HD22	1.94	0.48
1:A:303[B]:MET:HE1	1:A:364:MET:CG	2.42	0.48
1:A:341:PRO:CG	1:A:483:LEU:HD21	2.43	0.48
1:A:379:MET:HE3	1:A:379:MET:C	2.39	0.48
1:A:488:HIS:HE1	4:A:2064:HOH:O	1.96	0.48
1:A:413:GLN:CD	1:A:421:MET:HE2	2.39	0.47
1:A:31:ARG:N	4:A:2001:HOH:O	2.49	0.46
1:A:62:LYS:HG2	1:A:194:GLY:HA3	1.97	0.46
1:A:175:GLN:NE2	4:A:2469:HOH:O	2.49	0.46
1:A:439:ASP:O	1:A:440:MET:HE2	2.16	0.46
1:A:141:HIS:HB2	1:A:142:PRO:HD2	1.97	0.45
1:A:314:HIS:HD2	1:A:315:PRO:O	1.99	0.45
1:A:189:LYS:NZ	4:A:2434:HOH:O	2.50	0.45
1:A:406:HIS:HD2	4:A:2408:HOH:O	1.99	0.44
1:A:312:LYS:NZ	4:A:2357:HOH:O	2.50	0.44
1:A:488:HIS:HD2	4:A:2211:HOH:O	1.99	0.44
1:A:105:LEU:HA	1:A:133:GLN:HE22	1.84	0.43

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Atom-1	Atom-2	Interatomic distance (Å)	Clash overlap (Å)
1:A:74:LEU:HD21	1:A:186:GLN:HE22	1.84	0.42
1:A:100:LEU:O	1:A:113:GLY:HA3	2.18	0.42
1:A:355:MET:HG2	1:A:408:ASN:ND2	2.35	0.42
1:A:47:ARG:HD3	1:A:89:ASP:OD2	2.21	0.41
1:A:364:MET:CG	1:A:441:MET:HE1	2.50	0.41
1:A:343:LEU:HD13	1:A:343:LEU:N	2.36	0.40
1:A:364:MET:O	1:A:368:MET:HG2	2.22	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	462/488 (95%)	451 (98%)	11 (2%)	0	100	100

There are no Ramachandran outliers to report.

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	384/400 (96%)	369 (96%)	15 (4%)	28	5

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

Mol	Chain	Res	Type
1	A	49	GLN
1	A	199	GLN
1	A	202	VAL
1	A	325	SER
1	A	340	LEU
1	A	343	LEU
1	A	358	MET
1	A	359	LEU
1	A	361	MET
1	A	376	MET
1	A	379	MET
1	A	413	GLN
1	A	417	MET
1	A	419	LYS
1	A	470	LYS

Sometimes sidechains can be flipped to improve hydrogen bonding and reduce clashes. All (10) such sidechains are listed below:

Mol	Chain	Res	Type
1	A	133	GLN
1	A	175	GLN
1	A	186	GLN
1	A	314	HIS
1	A	374	GLN
1	A	406	HIS
1	A	408	ASN
1	A	413	GLN
1	A	487	ASN
1	A	488	HIS

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 3 ligands modelled in this entry, 2 are monoatomic - leaving 1 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	$\# Z > 2$
3	C2O	A	702	1	0,2,2	-	-	-		

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

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, 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	463/488 (94%)	0.15	27 (5%)	29 30	8, 16, 35, 66	3 (0%)

All (27) RSRZ outliers are listed below:

Mol	Chain	Res	Type	RSRZ
1	A	379	MET	5.0
1	A	403	ASP	4.0
1	A	341	PRO	3.8
1	A	44	ALA	3.4
1	A	339	ALA	3.2
1	A	340	LEU	3.2
1	A	63	THR	3.2
1	A	61	GLY	3.2
1	A	324	ILE	3.0
1	A	492	LYS	2.9
1	A	344	GLU	2.9
1	A	361	MET	2.8
1	A	171	MET	2.7
1	A	308	ALA	2.6
1	A	483	LEU	2.6
1	A	359	LEU	2.5
1	A	337	LEU	2.4
1	A	358	MET	2.4
1	A	460	LYS	2.4
1	A	419	LYS	2.3
1	A	377	ALA	2.1
1	A	413	GLN	2.1
1	A	326	ALA	2.1
1	A	429	TYR	2.1
1	A	425	ALA	2.0
1	A	343	LEU	2.0
1	A	342	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	CU	A	701	1/1	0.99	0.04	10,10,10,10	0
2	CU	A	703	1/1	0.99	0.27	30,30,30,30	0
3	C2O	A	702	3/3	0.99	0.10	14,14,14,22	0

6.5 Other polymers [i](#)

There are no such residues in this entry.