



Full wwPDB X-ray Structure Validation Report ⓘ

Mar 6, 2026 – 07:36 PM UTC

PDB ID : 5V38 / pdb_00005v38
Title : Crystal Structure of The Receptor-binding Domain of Botulinum Neurotoxin Type HA
Authors : Yao, G.; Lam, K.-H.; Jin, R.
Deposited on : 2017-03-06
Resolution : 1.80 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

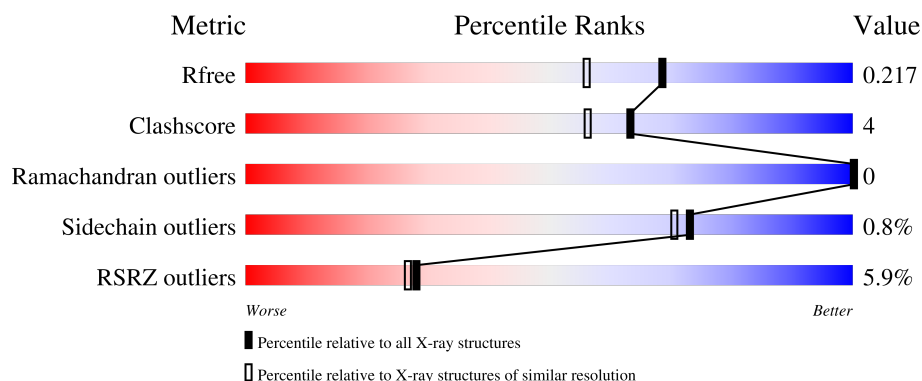
1 Overall quality at a glance

The following experimental techniques were used to determine the structure:

X-RAY DIFFRACTION

The reported resolution of this entry is 1.80 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	7662 (1.80-1.80)
Clashscore	190562	8479 (1.80-1.80)
Ramachandran outliers	187476	8391 (1.80-1.80)
Sidechain outliers	187428	8390 (1.80-1.80)
RSRZ outliers	180081	7663 (1.80-1.80)

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	435	6% 86% 9% .
1	B	435	6% 87% 8% .

2 Entry composition [i](#)

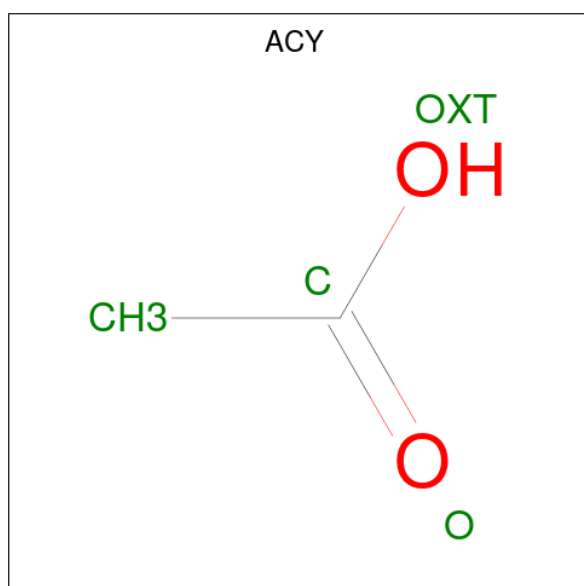
There are 3 unique types of molecules in this entry. The entry contains 7796 atoms, of which 0 are hydrogens and 0 are deuteriums.

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 HcHA.

Mol	Chain	Residues	Atoms					ZeroOcc	AltConf	Trace
1	A	418	Total	C	N	O	S	0	1	0
			3432	2183	586	648	15			
1	B	416	Total	C	N	O	S	0	0	0
			3410	2169	583	643	15			

- Molecule 2 is ACETIC ACID (CCD ID: ACY) (formula: C₂H₄O₂).



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

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

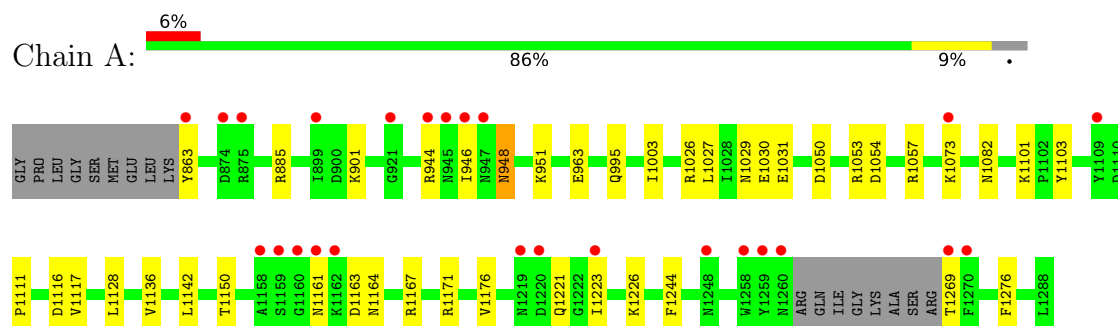
- Molecule 3 is water.

Mol	Chain	Residues	Atoms		ZeroOcc	AltConf
3	A	491	Total	O	0	0
			491	491		
3	B	435	Total	O	0	0
			435	435		

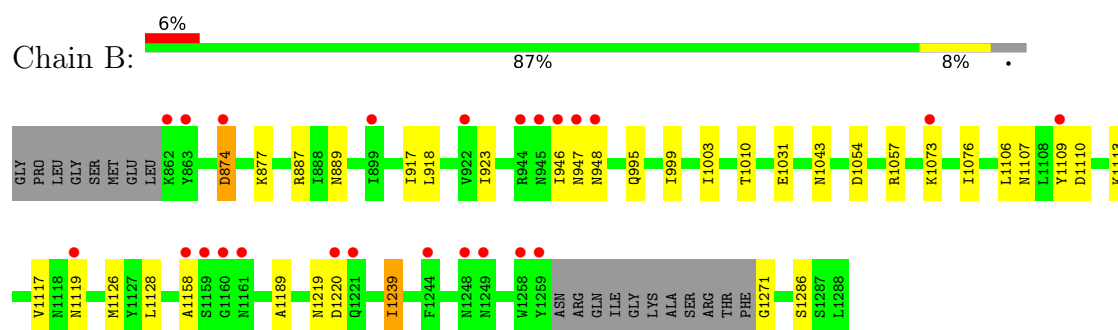
3 Residue-property plots [i](#)

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: HcHA



• Molecule 1: HcHA



4 Data and refinement statistics

Property	Value	Source
Space group	P 1 21 1	Depositor
Cell constants a, b, c, α , β , γ	77.94Å 80.12Å 78.38Å 90.00° 105.94° 90.00°	Depositor
Resolution (Å)	49.23 – 1.80 49.23 – 1.80	Depositor EDS
% Data completeness (in resolution range)	97.1 (49.23-1.80) 97.1 (49.23-1.80)	Depositor EDS
R_{merge}	(Not available)	Depositor
R_{sym}	(Not available)	Depositor
$\langle I/\sigma(I) \rangle$ ¹	2.13 (at 1.79Å)	Xtriage
Refinement program	PHENIX 1.9_1692	Depositor
R, R_{free}	0.179 , 0.217 0.180 , 0.217	Depositor DCC
R_{free} test set	1988 reflections (2.31%)	wwPDB-VP
Wilson B-factor (Å ²)	12.6	Xtriage
Anisotropy	0.662	Xtriage
Bulk solvent k_{sol} (e/Å ³), B_{sol} (Å ²)	0.36 , 50.7	EDS
L-test for twinning ²	$\langle L \rangle = 0.52$, $\langle L^2 \rangle = 0.36$	Xtriage
Estimated twinning fraction	0.000 for l,-k,h	Xtriage
F_o, F_c correlation	0.96	EDS
Total number of atoms	7796	wwPDB-VP
Average B, all atoms (Å ²)	22.0	wwPDB-VP

Xtriage's analysis on translational NCS is as follows: *The analyses of the Patterson function reveals a significant off-origin peak that is 50.83 % of the origin peak, indicating pseudo-translational symmetry. The chance of finding a peak of this or larger height randomly in a structure without pseudo-translational symmetry is equal to 6.1216e-05. The detected translational NCS is most likely also responsible for the elevated intensity ratio.*

¹ Intensities estimated from amplitudes.

² Theoretical 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: ACY

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	0.43	0/3505	0.70	0/4735
1	B	0.43	0/3479	0.71	2/4698 (0.0%)
All	All	0.43	0/6984	0.71	2/9433 (0.0%)

There are no bond length outliers.

All (2) bond angle outliers are listed below:

Mol	Chain	Res	Type	Atoms	Z	Observed(°)	Ideal(°)
1	B	1110	ASP	CA-C-N	5.75	125.42	119.56
1	B	1110	ASP	C-N-CA	5.75	125.42	119.56

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	3432	0	3369	31	1
1	B	3410	0	3354	24	1
2	A	16	0	12	0	0
2	B	12	0	9	1	0
3	A	491	0	0	17	1
3	B	435	0	0	10	1
All	All	7796	0	6744	55	2

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 4.

All (55) 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:946:ILE:HB	1:A:948:ASN:HB3	1.68	0.75
1:A:1082:ASN:O	3:A:1401:HOH:O	2.04	0.74
1:B:923:ILE:HD12	1:B:1043:ASN:HA	1.74	0.70
1:A:1164:ASN:OD1	3:A:1403:HOH:O	2.09	0.69
1:A:1026:ARG:NH1	3:A:1406:HOH:O	2.22	0.67
1:B:1271:GLY:N	3:B:1406:HOH:O	2.28	0.67
1:A:963:GLU:OE1	3:A:1404:HOH:O	2.14	0.66
1:A:1269:THR:N	3:A:1414:HOH:O	2.27	0.66
1:A:863:TYR:N	3:A:1415:HOH:O	2.29	0.66
1:A:1029[A]:ASN:OD1	3:A:1405:HOH:O	2.14	0.66
1:B:1158:ALA:O	3:B:1401:HOH:O	2.14	0.65
1:B:1117:VAL:HG22	1:B:1126:MET:HG2	1.79	0.64
1:A:1031:GLU:OE2	1:B:887:ARG:NH1	2.33	0.61
1:A:995:GLN:HA	1:A:1003:ILE:HD11	1.83	0.61
1:A:1171:ARG:NE	3:A:1407:HOH:O	2.25	0.61
1:A:885:ARG:NE	3:A:1418:HOH:O	2.34	0.60
1:B:1189:ALA:HB2	1:B:1239:ILE:HD13	1.83	0.59
1:A:1101:LYS:NZ	3:A:1419:HOH:O	2.36	0.59
1:A:885:ARG:NH1	3:A:1410:HOH:O	2.26	0.58
1:B:1107:ASN:OD1	1:B:1109:TYR:HB3	2.04	0.57
1:A:1161:ASN:HD22	1:A:1167:ARG:NH1	2.03	0.56
1:B:1057:ARG:HD3	3:B:1459:HOH:O	2.05	0.56
1:B:947:ASN:O	1:B:947:ASN:OD1	2.24	0.56
1:A:1054:ASP:HB3	1:A:1057:ARG:HG2	1.88	0.56
1:B:995:GLN:HA	1:B:1003:ILE:HD11	1.86	0.56
1:B:946:ILE:HG13	1:B:947:ASN:N	2.21	0.55
2:B:1303:ACY:C	3:B:1404:HOH:O	2.54	0.54
1:B:947:ASN:N	3:B:1411:HOH:O	2.40	0.53
1:A:1161:ASN:HD22	1:A:1167:ARG:HH12	1.55	0.53
1:A:1136:VAL:HG22	1:A:1142:LEU:HG	1.92	0.51
1:A:1053:ARG:NH1	3:A:1428:HOH:O	2.44	0.50
1:B:889:ASN:ND2	1:B:917:ILE:HD11	2.27	0.49
1:A:1027:LEU:H	1:A:1073:LYS:NZ	2.12	0.48
1:B:1113:LYS:HD3	1:B:1128:LEU:HB3	1.96	0.47
1:A:1163:ASP:HB2	3:A:1614:HOH:O	2.13	0.47
1:B:874:ASP:HB2	3:B:1585:HOH:O	2.15	0.46
1:A:885:ARG:HD3	3:A:1410:HOH:O	2.14	0.46

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Atom-1	Atom-2	Interatomic distance (Å)	Clash overlap (Å)
1:A:1223:ILE:O	1:A:1226:LYS:NZ	2.42	0.46
1:B:1054:ASP:HB3	1:B:1057:ARG:HG2	1.97	0.46
1:A:1128:LEU:HD13	1:A:1244:PHE:CZ	2.52	0.45
1:A:1116:ASP:OD1	1:A:1117:VAL:N	2.50	0.44
1:B:1073:LYS:HE3	3:B:1492:HOH:O	2.17	0.44
3:A:1611:HOH:O	1:B:877:LYS:HD3	2.17	0.43
1:B:1219:ASN:ND2	3:B:1430:HOH:O	2.51	0.43
1:A:901:LYS:NZ	3:A:1440:HOH:O	2.52	0.42
1:B:948:ASN:HB3	3:B:1763:HOH:O	2.19	0.42
1:A:951:LYS:HB2	1:A:1050:ASP:HB3	2.01	0.42
1:A:1150:THR:HG21	1:A:1176:VAL:HG13	2.01	0.41
1:B:1010:THR:HG21	1:B:1076:ILE:HG12	2.02	0.41
1:B:918:LEU:HB2	1:B:923:ILE:CD1	2.51	0.41
1:A:1026:ARG:NH2	1:A:1221:GLN:HB3	2.37	0.41
1:A:1103:TYR:CG	1:A:1276:PHE:HB3	2.56	0.41
1:A:1111:PRO:HB2	3:A:1536:HOH:O	2.20	0.40
1:B:999:ILE:HD13	1:B:1106:LEU:HD21	2.04	0.40
1:B:1031:GLU:OE1	3:B:1403:HOH:O	2.22	0.40

All (2) symmetry-related close contacts are listed below. The label for Atom-2 includes the symmetry operator and encoded unit-cell translations to be applied.

Atom-1	Atom-2	Interatomic distance (Å)	Clash overlap (Å)
3:A:1858:HOH:O	3:B:1780:HOH:O[2_955]	2.11	0.09
1:A:944:ARG:NH2	1:B:1286:SER:O[2_955]	2.16	0.04

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	415/435 (95%)	401 (97%)	14 (3%)	0	100 100

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Mol	Chain	Analysed	Favoured	Allowed	Outliers	Percentiles	
1	B	412/435 (95%)	397 (96%)	15 (4%)	0	100	100
All	All	827/870 (95%)	798 (96%)	29 (4%)	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	385/397 (97%)	383 (100%)	2 (0%)	81	80
1	B	382/397 (96%)	378 (99%)	4 (1%)	68	64
All	All	767/794 (97%)	761 (99%)	6 (1%)	73	70

All (6) residues with a non-rotameric sidechain are listed below:

Mol	Chain	Res	Type
1	A	948	ASN
1	A	1030	GLU
1	B	874	ASP
1	B	1119	ASN
1	B	1220	ASP
1	B	1239	ILE

Sometimes sidechains can be flipped to improve hydrogen bonding and reduce clashes. All (17) such sidechains are listed below:

Mol	Chain	Res	Type
1	A	905	GLN
1	A	947	ASN
1	A	972	ASN
1	A	1044	ASN
1	A	1065	ASN
1	A	1161	ASN
1	A	1164	ASN

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Mol	Chain	Res	Type
1	B	925	ASN
1	B	970	ASN
1	B	1038	ASN
1	B	1040	HIS
1	B	1065	ASN
1	B	1085	ASN
1	B	1098	GLN
1	B	1118	ASN
1	B	1219	ASN
1	B	1237	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 oligosaccharides in this entry.

5.6 Ligand geometry [i](#)

7 ligands are modelled in this entry.

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	ACY	A	1304	-	3,3,3	0.83	0	3,3,3	0.79	0
2	ACY	A	1302	-	3,3,3	0.80	0	3,3,3	0.93	0
2	ACY	A	1301	-	3,3,3	0.83	0	3,3,3	0.78	0
2	ACY	B	1301	-	3,3,3	0.83	0	3,3,3	0.76	0

Mol	Type	Chain	Res	Link	Bond lengths			Bond angles		
					Counts	RMSZ	$\# Z > 2$	Counts	RMSZ	$\# Z > 2$
2	ACY	B	1302	-	3,3,3	0.80	0	3,3,3	1.01	0
2	ACY	B	1303	-	3,3,3	0.80	0	3,3,3	0.56	0
2	ACY	A	1303	-	3,3,3	0.82	0	3,3,3	0.83	0

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.

1 monomer is involved in 1 short contact:

Mol	Chain	Res	Type	Clashes	Symm-Clashes
2	B	1303	ACY	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

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	418/435 (96%)	-0.17	25 (5%)	27 26	7, 17, 39, 67	11 (2%)
1	B	416/435 (95%)	-0.03	24 (5%)	29 27	8, 20, 42, 72	5 (1%)
All	All	834/870 (95%)	-0.10	49 (5%)	28 27	7, 18, 41, 72	16 (1%)

All (49) RSRZ outliers are listed below:

Mol	Chain	Res	Type	RSRZ
1	A	1160	GLY	8.6
1	A	946	ILE	5.9
1	B	1221	GLN	5.0
1	A	1258	TRP	4.8
1	B	863	TYR	4.6
1	A	1161	ASN	4.5
1	B	946	ILE	4.4
1	B	1109	TYR	4.2
1	A	1158	ALA	4.0
1	B	1220	ASP	4.0
1	B	1258	TRP	3.8
1	A	947	ASN	3.8
1	B	1259	TYR	3.7
1	A	1269	THR	3.6
1	A	1162	LYS	3.5
1	B	947	ASN	3.4
1	B	1248	ASN	3.4
1	B	1159	SER	3.3
1	A	874	ASP	3.3
1	B	862	LYS	3.3
1	A	1159	SER	3.3
1	A	875	ARG	3.1
1	B	1160	GLY	3.0
1	A	863	TYR	2.9

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Mol	Chain	Res	Type	RSRZ
1	A	1259	TYR	2.8
1	A	1260	ASN	2.8
1	B	1158	ALA	2.8
1	A	944	ARG	2.7
1	B	874	ASP	2.6
1	A	1109	TYR	2.6
1	B	1249	ASN	2.6
1	A	1219	ASN	2.5
1	B	1161	ASN	2.5
1	B	1073	LYS	2.5
1	A	899	ILE	2.5
1	A	1073	LYS	2.5
1	A	1270	PHE	2.4
1	B	944	ARG	2.4
1	B	922	VAL	2.4
1	A	1223	ILE	2.4
1	B	948	ASN	2.3
1	B	899	ILE	2.3
1	B	1244	PHE	2.2
1	A	945	ASN	2.2
1	B	1119	ASN	2.1
1	A	1248	ASN	2.1
1	A	921	GLY	2.1
1	B	945	ASN	2.1
1	A	1220	ASP	2.1

6.2 Non-standard residues in protein, DNA, RNA chains ⓘ

There are no non-standard protein/DNA/RNA residues in this entry.

6.3 Carbohydrates ⓘ

There are no oligosaccharides in this entry.

6.4 Ligands ⓘ

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	ACY	A	1303	4/4	0.70	0.21	46,47,47,51	0
2	ACY	A	1304	4/4	0.74	0.19	53,55,55,56	0
2	ACY	A	1301	4/4	0.89	0.12	40,40,41,43	0
2	ACY	B	1303	4/4	0.89	0.16	27,40,41,48	0
2	ACY	B	1301	4/4	0.93	0.14	17,24,25,30	0
2	ACY	B	1302	4/4	0.98	0.06	17,19,21,21	0
2	ACY	A	1302	4/4	0.99	0.04	12,15,16,20	0

6.5 Other polymers [i](#)

There are no such residues in this entry.