



Full wwPDB X-ray Structure Validation Report ⓘ

Mar 5, 2026 – 01:19 PM UTC

PDB ID : 6M2O / pdb_00006m2o
Title : Double mutant(H333A/I334A) crystal structure of benzoate coenzyme A ligase
Authors : Li, T.L.; Adhikari, K.
Deposited on : 2020-02-28
Resolution : 1.57 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

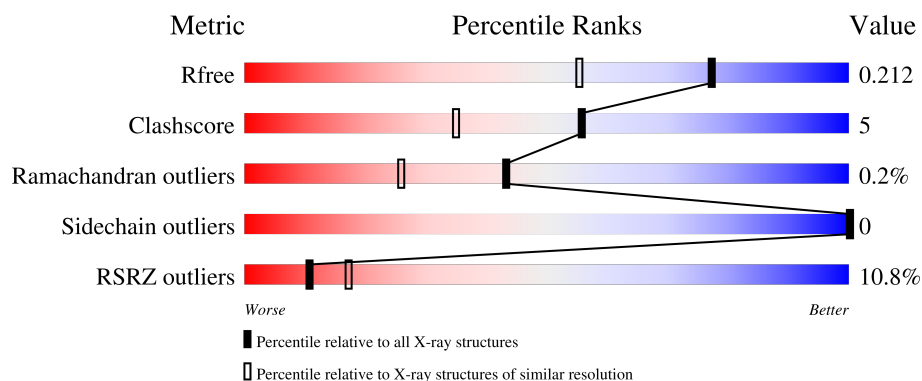
1 Overall quality at a glance

The following experimental techniques were used to determine the structure:

X-RAY DIFFRACTION

The reported resolution of this entry is 1.57 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	1094 (1.58-1.58)
Clashscore	190562	1105 (1.58-1.58)
Ramachandran outliers	187476	1082 (1.58-1.58)
Sidechain outliers	187428	1081 (1.58-1.58)
RSRZ outliers	180081	1094 (1.58-1.58)

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	524	7% 90% 9%
1	B	524	14% 91% 8%

2 Entry composition

There are 2 unique types of molecules in this entry. The entry contains 9008 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 Benzoate-coenzyme A ligase.

Mol	Chain	Residues	Atoms					ZeroOcc	AltConf	Trace
1	A	518	Total	C	N	O	S	0	3	0
			3914	2508	676	721	9			
1	B	518	Total	C	N	O	S	1	3	0
			3914	2508	676	721	9			

There are 12 discrepancies between the modelled and reference sequences:

Chain	Residue	Modelled	Actual	Comment	Reference
A	1	MET	-	initiating methionine	UNP Q93TK0
A	83	ALA	THR	engineered mutation	UNP Q93TK0
A	333	ALA	HIS	engineered mutation	UNP Q93TK0
A	334	ALA	ILE	engineered mutation	UNP Q93TK0
A	341	ASP	GLY	engineered mutation	UNP Q93TK0
A	524	GLY	-	expression tag	UNP Q93TK0
B	1	MET	-	initiating methionine	UNP Q93TK0
B	83	ALA	THR	engineered mutation	UNP Q93TK0
B	333	ALA	HIS	engineered mutation	UNP Q93TK0
B	334	ALA	ILE	engineered mutation	UNP Q93TK0
B	341	ASP	GLY	engineered mutation	UNP Q93TK0
B	524	GLY	-	expression tag	UNP Q93TK0

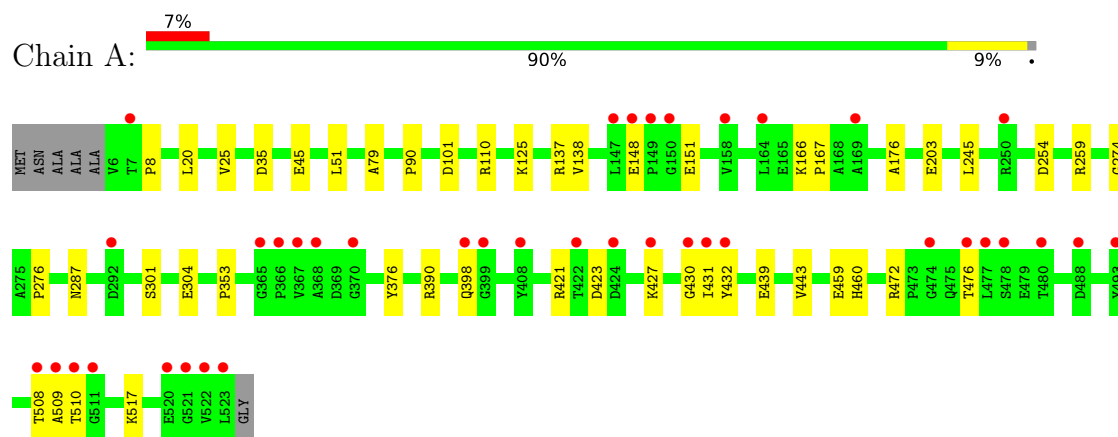
- Molecule 2 is water.

Mol	Chain	Residues	Atoms		ZeroOcc	AltConf
2	A	594	Total	O	0	0
			594	594		
2	B	586	Total	O	0	0
			586	586		

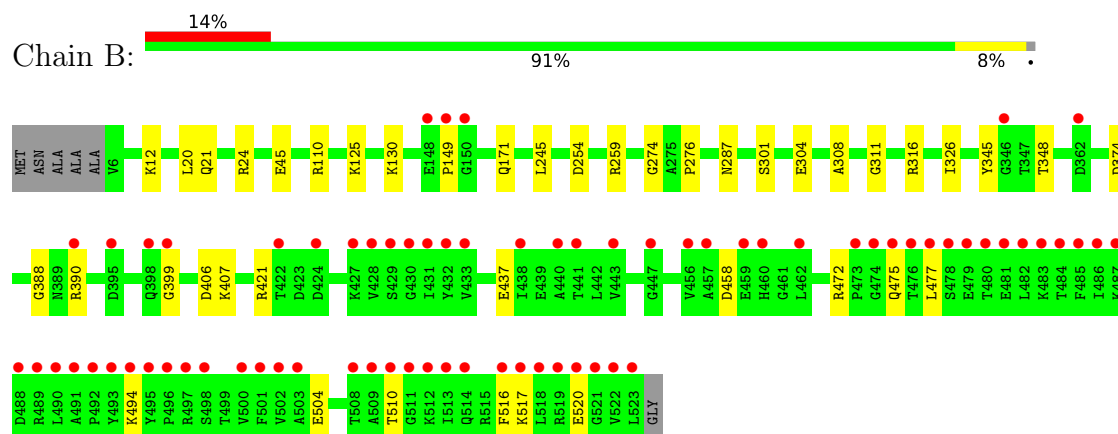
3 Residue-property plots [i](#)

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: Benzoate-coenzyme A ligase



• Molecule 1: Benzoate-coenzyme A ligase



4 Data and refinement statistics

Property	Value	Source
Space group	P 1 21 1	Depositor
Cell constants a, b, c, α , β , γ	59.12Å 95.38Å 94.99Å 90.00° 105.05° 90.00°	Depositor
Resolution (Å)	29.52 – 1.57 29.52 – 1.57	Depositor EDS
% Data completeness (in resolution range)	99.1 (29.52-1.57) 99.1 (29.52-1.57)	Depositor EDS
R_{merge}	(Not available)	Depositor
R_{sym}	(Not available)	Depositor
$\langle I/\sigma(I) \rangle$ ¹	3.58 (at 1.57Å)	Xtriage
Refinement program	PHENIX (1.11.1 _2575: ???)	Depositor
R, R_{free}	0.187 , 0.212 0.187 , 0.212	Depositor DCC
R_{free} test set	2006 reflections (1.42%)	wwPDB-VP
Wilson B-factor (Å ²)	12.4	Xtriage
Anisotropy	0.055	Xtriage
Bulk solvent k_{sol} (e/Å ³), B_{sol} (Å ²)	0.36 , 39.7	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	9008	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 4.35% 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](#)

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	0.34	1/4026 (0.0%)	0.56	0/5494
1	B	0.32	0/4026	0.54	0/5494
All	All	0.33	1/8052 (0.0%)	0.55	0/10988

All (1) bond length outliers are listed below:

Mol	Chain	Res	Type	Atoms	Z	Observed(Å)	Ideal(Å)
1	A	8	PRO	CA-C	-5.52	1.48	1.51

There are no bond angle outliers.

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	3914	0	3835	36	0
1	B	3914	0	3835	37	0
2	A	594	0	0	15	2
2	B	586	0	0	16	2
All	All	9008	0	7670	72	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 5.

All (72) 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:388:GLY:H	1:B:390:ARG:HH22	1.19	0.86
1:A:35:ASP:OD2	2:A:601:HOH:O	1.97	0.82
1:A:245:LEU:HD21	1:A:259:ARG:HG2	1.66	0.78
1:A:476:THR:O	2:A:602:HOH:O	2.06	0.72
1:B:520:GLU:O	2:B:601:HOH:O	2.06	0.71
1:A:510:THR:HG22	1:B:149:PRO:HG3	1.74	0.68
1:B:504:GLU:OE2	2:B:602:HOH:O	2.12	0.67
1:A:203:GLU:OE2	2:A:603:HOH:O	2.13	0.67
1:A:137:ARG:NH1	2:A:610:HOH:O	2.27	0.66
1:A:431:ILE:HA	2:A:605:HOH:O	1.94	0.66
1:B:494:LYS:NZ	2:B:603:HOH:O	2.13	0.66
1:B:517:LYS:HA	1:B:520:GLU:HB2	1.81	0.62
1:A:376:TYR:HE2	1:A:398:GLN:HE22	1.47	0.62
1:B:130:LYS:NZ	2:B:607:HOH:O	2.24	0.61
1:B:458:ASP:O	2:B:606:HOH:O	2.16	0.59
1:B:437:GLU:OE2	2:B:605:HOH:O	2.15	0.59
1:B:520:GLU:HB3	2:B:601:HOH:O	2.02	0.58
1:A:430:GLY:O	2:A:605:HOH:O	2.17	0.57
1:B:276:PRO:HD2	1:B:304:GLU:HG2	1.85	0.57
1:A:110:ARG:NH2	2:A:615:HOH:O	2.36	0.57
1:B:388:GLY:N	1:B:390:ARG:HH22	1.96	0.57
1:B:308:ALA:CB	2:B:868:HOH:O	2.56	0.54
1:A:25:VAL:HG13	2:A:666:HOH:O	2.08	0.54
1:B:245:LEU:HD21	1:B:259:ARG:HG2	1.90	0.54
1:A:508:THR:C	1:A:510:THR:H	2.16	0.53
1:A:472:ARG:NH1	2:A:619:HOH:O	2.41	0.53
1:B:477:LEU:N	2:B:615:HOH:O	2.41	0.52
1:A:51:LEU:CD2	1:A:79:ALA:HA	2.40	0.52
1:A:125:LYS:HG3	2:A:827:HOH:O	2.10	0.51
1:B:308:ALA:HA	1:B:345:TYR:HB3	1.92	0.51
1:B:472:ARG:HB3	1:B:475:GLN:HG3	1.93	0.51
1:B:110:ARG:NH2	2:B:620:HOH:O	2.43	0.51
1:B:326:ILE:HG22	1:B:348:THR:HG21	1.92	0.50
1:B:21:GLN:OE1	1:B:24:ARG:NH1	2.39	0.50
1:B:374:ASP:OD1	1:B:407:LYS:NZ	2.43	0.50
1:B:406:ASP:OD1	1:B:421:ARG:NH1	2.42	0.50
1:B:388:GLY:H	1:B:390:ARG:NH2	1.97	0.50
1:B:20:LEU:HD13	1:B:45:GLU:HG3	1.95	0.48
1:A:276:PRO:HD2	1:A:304:GLU:HG2	1.94	0.48
1:B:12:LYS:HE3	1:B:171:GLN:OE1	2.15	0.47
1:B:311:GLY:HA3	1:B:345:TYR:CE1	2.50	0.47
1:B:390:ARG:NH2	2:B:626:HOH:O	2.48	0.46

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Atom-1	Atom-2	Interatomic distance (Å)	Clash overlap (Å)
1:B:316:ARG:NH2	2:B:613:HOH:O	2.40	0.46
1:A:390:ARG:NH2	2:A:625:HOH:O	2.48	0.46
1:A:148:GLU:O	1:A:151:GLU:HB2	2.17	0.45
1:A:443[A]:VAL:HG21	1:B:125:LYS:HD3	1.99	0.45
1:B:254:ASP:OD1	1:B:287:ASN:ND2	2.43	0.44
1:A:508:THR:C	1:A:510:THR:N	2.75	0.44
1:B:308:ALA:HB3	2:B:868:HOH:O	2.16	0.44
1:A:138:VAL:HB	1:A:151:GLU:HG2	1.98	0.44
1:A:254:ASP:OD1	1:A:287:ASN:ND2	2.36	0.44
1:A:166:LYS:HG3	1:A:167:PRO:HD2	2.00	0.43
1:A:421:ARG:HH21	1:A:423:ASP:CG	2.26	0.43
1:A:90:PRO:HD2	1:A:176:ALA:O	2.19	0.43
1:B:245:LEU:HD21	1:B:259:ARG:CG	2.48	0.43
1:A:20:LEU:HD13	1:A:45:GLU:HG3	2.01	0.42
1:A:101:ASP:HA	2:A:942:HOH:O	2.19	0.42
1:A:274:GLY:O	1:A:301[A]:SER:HA	2.20	0.42
1:B:274:GLY:O	1:B:301[B]:SER:HA	2.20	0.42
1:B:510:THR:HG21	2:B:1144:HOH:O	2.19	0.42
1:A:398:GLN:NE2	2:A:632:HOH:O	2.52	0.42
1:A:439:GLU:O	1:A:443[B]:VAL:HG23	2.20	0.41
1:A:274:GLY:O	1:A:301[B]:SER:HA	2.20	0.41
1:A:517:LYS:NZ	2:A:633:HOH:O	2.53	0.41
1:A:427:LYS:HE3	1:A:432:TYR:CD1	2.55	0.41
1:B:316:ARG:NE	2:B:613:HOH:O	2.35	0.41
1:A:353:PRO:HD2	2:A:910:HOH:O	2.21	0.41
1:A:427:LYS:HD3	1:A:427:LYS:HA	1.86	0.41
1:B:516:PHE:CE2	1:B:517:LYS:HG3	2.56	0.40
1:B:326:ILE:CG2	1:B:348:THR:HG21	2.52	0.40
1:A:459:GLU:HG2	1:A:460:HIS:CD2	2.56	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)
2:A:966:HOH:O	2:B:963:HOH:O[1_554]	1.86	0.34
2:A:1066:HOH:O	2:B:833:HOH:O[1_554]	2.17	0.03

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	519/524 (99%)	510 (98%)	8 (2%)	1 (0%)	43	26
1	B	519/524 (99%)	510 (98%)	8 (2%)	1 (0%)	43	26
All	All	1038/1048 (99%)	1020 (98%)	16 (2%)	2 (0%)	43	26

All (2) Ramachandran outliers are listed below:

Mol	Chain	Res	Type
1	A	509	ALA
1	B	399	GLY

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	395/412 (96%)	395 (100%)	0	100	100
1	B	395/412 (96%)	395 (100%)	0	100	100
All	All	790/824 (96%)	790 (100%)	0	100	100

There are no protein residues with a non-rotameric sidechain to report.

Sometimes sidechains can be flipped to improve hydrogen bonding and reduce clashes. All (4) such sidechains are listed below:

Mol	Chain	Res	Type
1	A	161	HIS
1	A	398	GLN

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Mol	Chain	Res	Type
1	B	211	HIS
1	B	378	HIS

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](#)

There are no ligands in this entry.

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	518/524 (98%)	0.37	39 (7%)	20 30	6, 16, 35, 53	4 (0%)
1	B	518/524 (98%)	0.64	73 (14%)	6 10	6, 16, 49, 64	4 (0%)
All	All	1036/1048 (98%)	0.50	112 (10%)	11 17	6, 16, 41, 64	8 (0%)

All (112) RSRZ outliers are listed below:

Mol	Chain	Res	Type	RSRZ
1	B	522	VAL	11.3
1	B	490	LEU	9.8
1	A	150	GLY	9.3
1	B	521	GLY	9.0
1	B	486	ILE	8.0
1	A	509	ALA	7.6
1	B	523	LEU	7.6
1	B	520	GLU	7.4
1	A	510	THR	7.4
1	B	485	PHE	7.3
1	B	492	PRO	7.0
1	B	491	ALA	6.7
1	B	493	TYR	6.6
1	B	510	THR	6.3
1	A	149	PRO	6.3
1	B	476	THR	6.2
1	B	495	TYR	6.1
1	A	508	THR	6.0
1	A	522	VAL	5.6
1	B	509	ALA	5.3
1	B	484	THR	5.2
1	B	496	PRO	5.2
1	B	428	VAL	5.1
1	B	477	LEU	5.1

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Mol	Chain	Res	Type	RSRZ
1	B	482	LEU	5.0
1	B	431	ILE	4.9
1	B	432	TYR	4.8
1	B	149	PRO	4.8
1	B	480	THR	4.8
1	B	488	ASP	4.6
1	B	427	LYS	4.6
1	B	498	SER	4.5
1	A	366	PRO	4.4
1	B	479	GLU	4.4
1	B	511	GLY	4.3
1	A	398	GLN	4.3
1	B	474	GLY	4.2
1	B	518	LEU	4.2
1	B	478	SER	4.2
1	A	511	GLY	4.2
1	A	474	GLY	4.1
1	B	497	ARG	4.1
1	A	147	LEU	4.1
1	B	422	THR	4.0
1	B	503	ALA	4.0
1	A	476	THR	3.9
1	B	508	THR	3.8
1	A	432	TYR	3.7
1	A	488	ASP	3.7
1	B	516	PHE	3.7
1	A	521	GLY	3.6
1	B	475	GLN	3.5
1	A	368	ALA	3.5
1	B	481	GLU	3.5
1	B	441	THR	3.5
1	B	494	LYS	3.5
1	B	519	ARG	3.5
1	A	480	THR	3.4
1	B	430	GLY	3.4
1	A	493	TYR	3.4
1	B	398	GLN	3.4
1	B	500	VAL	3.3
1	A	430	GLY	3.2
1	A	523	LEU	3.2
1	B	487	LYS	3.1
1	B	489	ARG	3.1

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Mol	Chain	Res	Type	RSRZ
1	B	424	ASP	3.1
1	B	483	LYS	3.1
1	B	473	PRO	3.1
1	B	501	PHE	3.1
1	A	427	LYS	3.1
1	B	362	ASP	3.0
1	B	399	GLY	3.0
1	A	250	ARG	2.9
1	B	517	LYS	2.8
1	B	462	LEU	2.8
1	B	460	HIS	2.7
1	A	367	VAL	2.7
1	A	399	GLY	2.7
1	A	164	LEU	2.6
1	B	433	VAL	2.6
1	B	346	GLY	2.6
1	A	431	ILE	2.6
1	A	520	GLU	2.6
1	B	148	GLU	2.4
1	A	422	THR	2.4
1	A	148	GLU	2.4
1	B	447	GLY	2.4
1	B	440	ALA	2.4
1	B	459	GLU	2.3
1	B	390	ARG	2.3
1	B	502	VAL	2.3
1	A	365	GLY	2.3
1	B	514	GLN	2.3
1	B	443[A]	VAL	2.3
1	A	424	ASP	2.3
1	A	370	GLY	2.3
1	B	513	ILE	2.3
1	B	512	LYS	2.2
1	A	408	TYR	2.1
1	B	429	SER	2.1
1	A	478	SER	2.1
1	A	169	ALA	2.1
1	B	150	GLY	2.1
1	A	7	THR	2.1
1	A	292	ASP	2.1
1	A	158	VAL	2.0
1	B	438	ILE	2.0

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Mol	Chain	Res	Type	RSRZ
1	B	457	ALA	2.0
1	B	456	VAL	2.0
1	A	477	LEU	2.0
1	B	395	ASP	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](#)

There are no ligands in this entry.

6.5 Other polymers [i](#)

There are no such residues in this entry.