



Full wwPDB X-ray Structure Validation Report ⓘ

Mar 9, 2026 – 01:44 PM UTC

PDB ID : 2OL7 / pdb_00002ol7
Title : The crystal structure of OspA mutant
Authors : Makabe, K.; Terechko, V.; Koide, S.
Deposited on : 2007-01-18
Resolution : 1.35 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

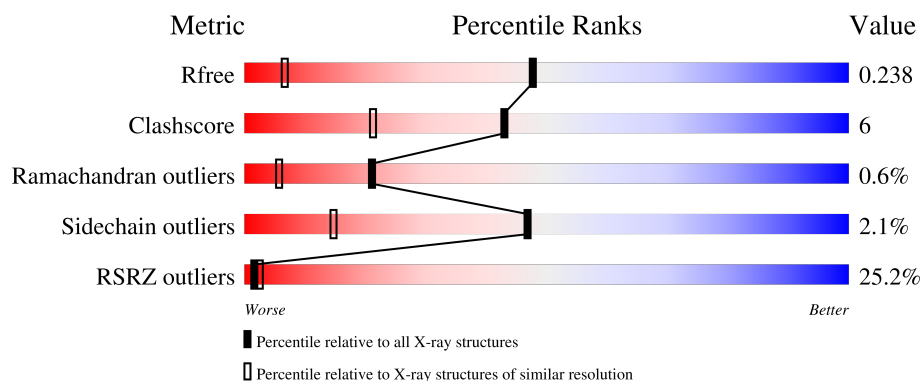
1 Overall quality at a glance

The following experimental techniques were used to determine the structure:

X-RAY DIFFRACTION

The reported resolution of this entry is 1.35 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	1216 (1.36-1.36)
Clashscore	190562	1232 (1.36-1.36)
Ramachandran outliers	187476	1220 (1.36-1.36)
Sidechain outliers	187428	1220 (1.36-1.36)
RSRZ outliers	180081	1214 (1.36-1.36)

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	251	8% 92% 6%
1	B	251	42% 87% 8%

2 Entry composition

There are 2 unique types of molecules in this entry. The entry contains 4335 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 Outer surface protein A.

Mol	Chain	Residues	Atoms					ZeroOcc	AltConf	Trace
1	A	250	Total	C	N	O	S	0	15	0
			1921	1197	309	412	3			
1	B	246	Total	C	N	O	S	0	7	0
			1846	1145	300	400	1			

There are 46 discrepancies between the modelled and reference sequences:

Chain	Residue	Modelled	Actual	Comment	Reference
A	23	GLY	-	expression tag	UNP Q45040
A	24	SER	-	expression tag	UNP Q45040
A	25	HIS	-	expression tag	UNP Q45040
A	26	MET	-	expression tag	UNP Q45040
A	37	SER	GLU	engineered mutation	UNP Q45040
A	45	SER	GLU	engineered mutation	UNP Q45040
A	46	SER	LYS	engineered mutation	UNP Q45040
A	48	ALA	LYS	engineered mutation	UNP Q45040
A	60	ALA	LYS	engineered mutation	UNP Q45040
A	64	SER	LYS	engineered mutation	UNP Q45040
A	83	ALA	LYS	engineered mutation	UNP Q45040
A	104	SER	GLU	engineered mutation	UNP Q45040
A	107	SER	LYS	engineered mutation	UNP Q45040
A	126	ILE	PHE	engineered mutation	UNP Q45040
A	127	ILE	ASN	engineered mutation	UNP Q45040
A	128	ILE	GLU	engineered mutation	UNP Q45040
A	129	ASP	LYS	engineered mutation	UNP Q45040
A	131	ILE	GLU	engineered mutation	UNP Q45040
A	132	ILE	VAL	engineered mutation	UNP Q45040
A	133	ILE	SER	engineered mutation	UNP Q45040
A	239	SER	LYS	engineered mutation	UNP Q45040
A	240	SER	GLU	engineered mutation	UNP Q45040
A	254	SER	LYS	engineered mutation	UNP Q45040
B	23	GLY	-	expression tag	UNP Q45040
B	24	SER	-	expression tag	UNP Q45040

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Chain	Residue	Modelled	Actual	Comment	Reference
B	25	HIS	-	expression tag	UNP Q45040
B	26	MET	-	expression tag	UNP Q45040
B	37	SER	GLU	engineered mutation	UNP Q45040
B	45	SER	GLU	engineered mutation	UNP Q45040
B	46	SER	LYS	engineered mutation	UNP Q45040
B	48	ALA	LYS	engineered mutation	UNP Q45040
B	60	ALA	LYS	engineered mutation	UNP Q45040
B	64	SER	LYS	engineered mutation	UNP Q45040
B	83	ALA	LYS	engineered mutation	UNP Q45040
B	104	SER	GLU	engineered mutation	UNP Q45040
B	107	SER	LYS	engineered mutation	UNP Q45040
B	126	ILE	PHE	engineered mutation	UNP Q45040
B	127	ILE	ASN	engineered mutation	UNP Q45040
B	128	ILE	GLU	engineered mutation	UNP Q45040
B	129	ASP	LYS	engineered mutation	UNP Q45040
B	131	ILE	GLU	engineered mutation	UNP Q45040
B	132	ILE	VAL	engineered mutation	UNP Q45040
B	133	ILE	SER	engineered mutation	UNP Q45040
B	239	SER	LYS	engineered mutation	UNP Q45040
B	240	SER	GLU	engineered mutation	UNP Q45040
B	254	SER	LYS	engineered mutation	UNP Q45040

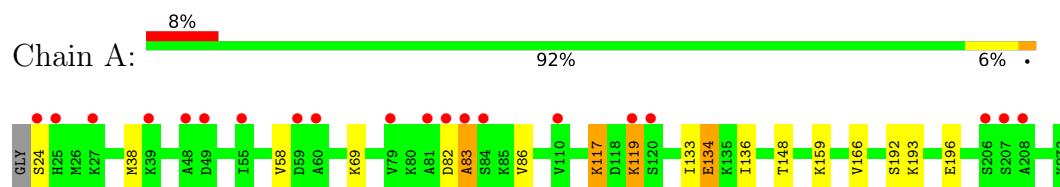
- Molecule 2 is water.

Mol	Chain	Residues	Atoms	ZeroOcc	AltConf
2	A	350	Total O 350 350	0	0
2	B	218	Total O 218 218	0	0

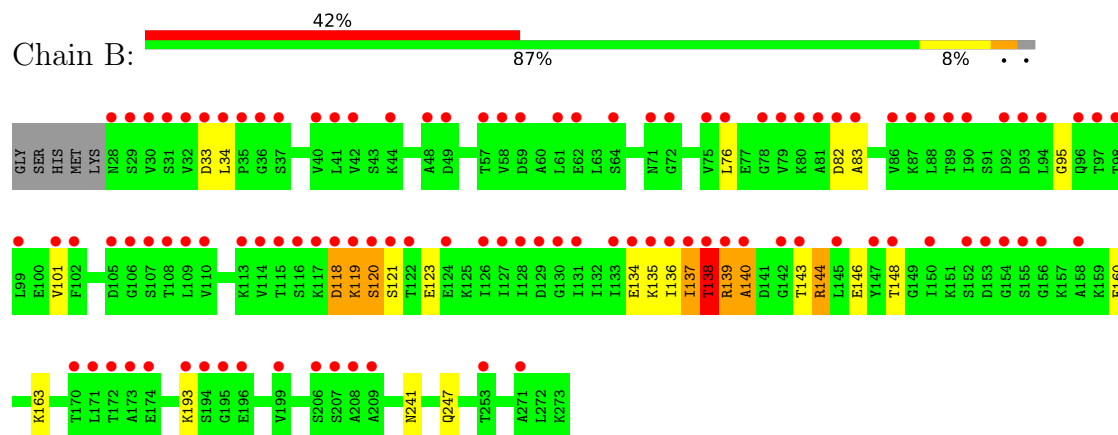
3 Residue-property plots [i](#)

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: Outer surface protein A



- Molecule 1: Outer surface protein A



4 Data and refinement statistics

Property	Value	Source
Space group	P 1	Depositor
Cell constants a, b, c, α , β , γ	37.13Å 55.33Å 64.79Å 85.68° 74.05° 86.45°	Depositor
Resolution (Å)	20.00 – 1.35 20.00 – 1.35	Depositor EDS
% Data completeness (in resolution range)	95.2 (20.00-1.35) 95.2 (20.00-1.35)	Depositor EDS
R_{merge}	0.07	Depositor
R_{sym}	(Not available)	Depositor
$\langle I/\sigma(I) \rangle$ ¹	4.27 (at 1.35Å)	Xtriage
Refinement program	REFMAC 5.2.0005	Depositor
R, R_{free}	0.184 , 0.218 0.209 , 0.238	Depositor DCC
R_{free} test set	5140 reflections (4.75%)	wwPDB-VP
Wilson B-factor (Å ²)	13.7	Xtriage
Anisotropy	0.378	Xtriage
Bulk solvent k_{sol} (e/Å ³), B_{sol} (Å ²)	0.43 , 52.2	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	0.94	EDS
Total number of atoms	4335	wwPDB-VP
Average B, all atoms (Å ²)	18.0	wwPDB-VP

Xtriage's analysis on translational NCS is as follows: *The largest off-origin peak in the Patterson function is 6.51% 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

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	0.78	2/1975 (0.1%)	0.78	0/2653
1	B	0.75	1/1875 (0.1%)	0.78	0/2523
All	All	0.77	3/3850 (0.1%)	0.78	0/5176

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	B	0	3

All (3) bond length outliers are listed below:

Mol	Chain	Res	Type	Atoms	Z	Observed(Å)	Ideal(Å)
1	B	76	LEU	C-O	-6.14	1.16	1.23
1	A	83	ALA	CA-C	5.16	1.60	1.52
1	A	86	VAL	N-CA	5.01	1.52	1.46

There are no bond angle outliers.

There are no chirality outliers.

All (3) planarity outliers are listed below:

Mol	Chain	Res	Type	Group
1	B	119	LYS	Peptide
1	B	137	ILE	Peptide
1	B	138	THR	Peptide

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	1921	0	2041	16	0
1	B	1846	0	1940	32	0
2	A	350	0	0	6	0
2	B	218	0	0	8	0
All	All	4335	0	3981	48	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 6.

All (48) 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:119:LYS:HB2	1:B:120:SER:HB3	1.29	1.15
1:A:69:LYS:HE2	2:A:524:HOH:O	1.52	1.07
1:B:119:LYS:HB2	1:B:120:SER:CB	1.95	0.97
1:B:139:ARG:HB2	1:B:143:THR:O	1.72	0.88
1:B:119:LYS:CB	1:B:120:SER:HB3	2.04	0.87
1:B:101:VAL:HG13	2:B:362:HOH:O	1.76	0.85
1:A:136:ILE:HD11	2:A:619:HOH:O	1.84	0.77
1:B:135:LYS:NZ	1:B:137:ILE:HD11	2.02	0.73
1:B:144:ARG:HE	1:B:146:GLU:CD	2.01	0.68
1:A:192:SER:OG	1:A:196[B]:GLU:HG2	1.94	0.67
1:B:123:GLU:CD	1:B:135:LYS:HE2	2.22	0.65
1:B:135:LYS:HZ3	1:B:137:ILE:HD11	1.62	0.63
1:B:139:ARG:O	1:B:140:ALA:HB2	2.02	0.60
1:B:121:SER:HA	1:B:139:ARG:O	2.03	0.59
1:B:119:LYS:CB	1:B:120:SER:CB	2.74	0.58
1:A:119:LYS:HD2	1:A:119:LYS:H	1.68	0.57
1:B:135:LYS:HA	2:B:347:HOH:O	2.05	0.56
1:A:148:THR:HG22	2:A:619:HOH:O	2.06	0.55
1:A:119:LYS:H	1:A:119:LYS:CD	2.19	0.55
1:A:24:SER:N	2:A:610:HOH:O	2.40	0.54
1:B:139:ARG:O	1:B:140:ALA:CB	2.56	0.53
1:B:148:THR:HG22	2:B:422:HOH:O	2.08	0.53
1:B:119:LYS:N	1:B:120:SER:OG	2.42	0.52

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Atom-1	Atom-2	Interatomic distance (Å)	Clash overlap (Å)
1:B:134:GLU:C	2:B:347:HOH:O	2.52	0.52
1:B:119:LYS:HB2	1:B:120:SER:OG	2.08	0.52
1:B:33:ASP:OD1	1:B:34:LEU:N	2.43	0.51
1:A:38[B]:MET:CE	1:A:58:VAL:HG22	2.44	0.48
1:B:123:GLU:OE2	1:B:135:LYS:HE2	2.13	0.48
1:A:159:LYS:HG3	1:A:166:VAL:CG1	2.44	0.48
1:A:148:THR:CG2	2:A:619:HOH:O	2.63	0.47
1:B:123:GLU:OE2	1:B:135:LYS:CE	2.63	0.47
1:A:133:ILE:O	1:A:134[A]:GLU:HG2	2.15	0.46
1:B:148:THR:O	2:B:408:HOH:O	2.21	0.44
1:B:118:ASP:N	1:B:118:ASP:OD1	2.51	0.44
1:B:136:ILE:HG22	1:B:138:THR:OG1	2.16	0.44
1:B:247:GLN:NE2	2:B:416:HOH:O	2.42	0.44
1:B:120:SER:O	1:B:139:ARG:O	2.34	0.44
1:A:192:SER:CB	1:A:196[B]:GLU:HG2	2.48	0.43
1:B:95:GLY:HA2	2:B:443:HOH:O	2.18	0.43
1:B:82:ASP:O	1:B:83:ALA:HB3	2.19	0.42
1:A:82:ASP:O	1:A:83:ALA:HB3	2.20	0.42
1:A:117:LYS:HZ3	1:A:117:LYS:HB3	1.85	0.42
1:B:139:ARG:NH2	1:B:160:GLU:OE2	2.53	0.41
1:A:159:LYS:CG	1:A:166:VAL:CG1	2.99	0.41
1:A:38[A]:MET:HE2	2:A:470:HOH:O	2.21	0.41
1:B:163[A]:LYS:HG2	2:B:301:HOH:O	2.21	0.41
1:B:123:GLU:OE2	1:B:135:LYS:NZ	2.53	0.40
1:B:139:ARG:NH2	1:B:241:ASN:CG	2.79	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	263/251 (105%)	259 (98%)	4 (2%)	0	100	100

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Mol	Chain	Analysed	Favoured	Allowed	Outliers	Percentiles	
1	B	251/251 (100%)	243 (97%)	5 (2%)	3 (1%)	10	1
All	All	514/502 (102%)	502 (98%)	9 (2%)	3 (1%)	21	6

All (3) Ramachandran outliers are listed below:

Mol	Chain	Res	Type
1	B	120	SER
1	B	140	ALA
1	B	138	THR

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	231/216 (107%)	226 (98%)	5 (2%)	45	14
1	B	219/216 (101%)	214 (98%)	5 (2%)	44	13
All	All	450/432 (104%)	440 (98%)	10 (2%)	47	14

All (10) residues with a non-rotameric sidechain are listed below:

Mol	Chain	Res	Type
1	A	117	LYS
1	A	119	LYS
1	A	134[A]	GLU
1	A	134[B]	GLU
1	A	193	LYS
1	B	118	ASP
1	B	138	THR
1	B	139	ARG
1	B	144	ARG
1	B	193	LYS

Sometimes sidechains can be flipped to improve hydrogen bonding and reduce clashes. All (6) such sidechains are listed below:

Mol	Chain	Res	Type
1	A	251	ASN
1	A	270	ASN
1	B	28	ASN
1	B	241	ASN
1	B	247	GLN
1	B	270	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](#)

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	250/251 (99%)	0.51	20 (8%)	18 25	6, 13, 22, 29	15 (6%)
1	B	246/251 (98%)	2.00	105 (42%)	0 1	8, 21, 29, 34	7 (2%)
All	All	496/502 (98%)	1.25	125 (25%)	1 2	6, 16, 28, 34	22 (4%)

All (125) RSRZ outliers are listed below:

Mol	Chain	Res	Type	RSRZ
1	B	138	THR	7.7
1	B	120	SER	6.1
1	B	140	ALA	5.5
1	B	126	ILE	5.1
1	B	109	LEU	5.1
1	B	32	VAL	5.0
1	B	115	THR	5.0
1	B	28	ASN	4.9
1	B	208	ALA	4.9
1	B	173	ALA	4.8
1	B	137	ILE	4.7
1	B	119	LYS	4.7
1	B	139	ARG	4.7
1	A	81	ALA	4.7
1	B	152	SER	4.7
1	B	33	ASP	4.6
1	B	148	THR	4.6
1	B	118	ASP	4.5
1	B	133	ILE	4.4
1	B	154	GLY	4.2
1	B	131	ILE	4.2
1	B	114	VAL	4.2
1	B	136	ILE	4.2
1	B	116	SER	4.1

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Mol	Chain	Res	Type	RSRZ
1	B	30	VAL	4.1
1	B	121	SER	4.0
1	B	117	LYS	4.0
1	B	37	SER	3.9
1	B	58	VAL	3.9
1	B	101	VAL	3.9
1	B	172	THR	3.9
1	B	29	SER	3.9
1	B	110	VAL	3.7
1	B	61	LEU	3.7
1	B	75	VAL	3.7
1	B	59	ASP	3.7
1	B	194	SER	3.7
1	B	102	PHE	3.6
1	B	108	THR	3.5
1	B	128	ILE	3.5
1	B	158	ALA	3.4
1	B	129	ASP	3.4
1	B	134	GLU	3.4
1	B	127	ILE	3.4
1	B	88	LEU	3.3
1	B	35	PRO	3.3
1	B	40	VAL	3.3
1	B	79	VAL	3.3
1	B	36	GLY	3.3
1	B	94	LEU	3.3
1	B	62	GLU	3.3
1	B	122	THR	3.2
1	B	206	SER	3.2
1	B	93	ASP	3.2
1	B	142	GLY	3.2
1	A	208	ALA	3.2
1	B	42	VAL	3.1
1	B	106	GLY	3.1
1	B	89	THR	3.1
1	A	83	ALA	3.0
1	B	71	ASN	3.0
1	B	155	SER	3.0
1	B	124	GLU	3.0
1	A	82	ASP	3.0
1	B	153	ASP	2.9
1	A	25	HIS	2.9

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Mol	Chain	Res	Type	RSRZ
1	B	174	GLU	2.9
1	A	60	ALA	2.9
1	B	143	THR	2.8
1	B	113	LYS	2.8
1	B	130	GLY	2.8
1	B	98	THR	2.8
1	B	92	ASP	2.8
1	B	147	TYR	2.8
1	A	59[A]	ASP	2.8
1	B	96	GLN	2.7
1	A	120	SER	2.7
1	A	206	SER	2.7
1	B	135	LYS	2.7
1	B	99	LEU	2.7
1	B	44	LYS	2.6
1	B	49	ASP	2.6
1	B	86	VAL	2.6
1	B	105	ASP	2.6
1	A	24	SER	2.6
1	B	78	GLY	2.5
1	B	57	THR	2.5
1	B	41	LEU	2.5
1	B	83	ALA	2.4
1	B	81	ALA	2.4
1	B	82	ASP	2.4
1	B	97	THR	2.4
1	A	207	SER	2.4
1	B	72	GLY	2.4
1	A	48	ALA	2.4
1	A	55	ILE	2.3
1	B	150	ILE	2.3
1	A	79	VAL	2.3
1	A	110	VAL	2.3
1	B	207	SER	2.3
1	B	31	SER	2.3
1	B	156	GLY	2.3
1	B	209	ALA	2.3
1	B	253	THR	2.2
1	A	84	SER	2.2
1	A	49	ASP	2.2
1	A	119	LYS	2.2
1	B	196	GLU	2.1

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Mol	Chain	Res	Type	RSRZ
1	B	64	SER	2.1
1	B	199	VAL	2.1
1	B	87	LYS	2.1
1	B	193	LYS	2.1
1	B	90	ILE	2.1
1	B	195	GLY	2.1
1	B	34	LEU	2.1
1	B	145	LEU	2.1
1	B	171	LEU	2.1
1	A	27	LYS	2.1
1	B	80	LYS	2.1
1	B	107	SER	2.0
1	B	170	THR	2.0
1	B	76	LEU	2.0
1	B	48	ALA	2.0
1	B	271	ALA	2.0
1	A	39[A]	LYS	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.