



# Full wwPDB X-ray Structure Validation Report ⓘ

Oct 22, 2024 – 12:35 PM EDT

PDB ID : 4NOL  
Title : Crystal structure of proenzyme asparaginyl endopeptidase (AEP)/Legumain mutant D233A at pH 7.5  
Authors : Zhao, L.; Hua, T.; Ru, H.; Ni, X.; Shaw, N.; Jiao, L.; Ding, W.; Qu, L.; Ouyang, S.; Liu, Z.J.  
Deposited on : 2013-11-19  
Resolution : 2.70 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](mailto: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>.

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The following versions of software and data (see [references ⓘ](#)) were used in the production of this report:

MolProbity	:	4.02b-467
Xtriage (Phenix)	:	1.20.1
EDS	:	3.0
Percentile statistics	:	20231227.v01 (using entries in the PDB archive December 27th 2023)
CCP4	:	9.0.003 (Gargrove)
Density-Fitness	:	1.0.11
Ideal geometry (proteins)	:	Engh & Huber (2001)
Ideal geometry (DNA, RNA)	:	Parkinson et al. (1996)
Validation Pipeline (wwPDB-VP)	:	2.39

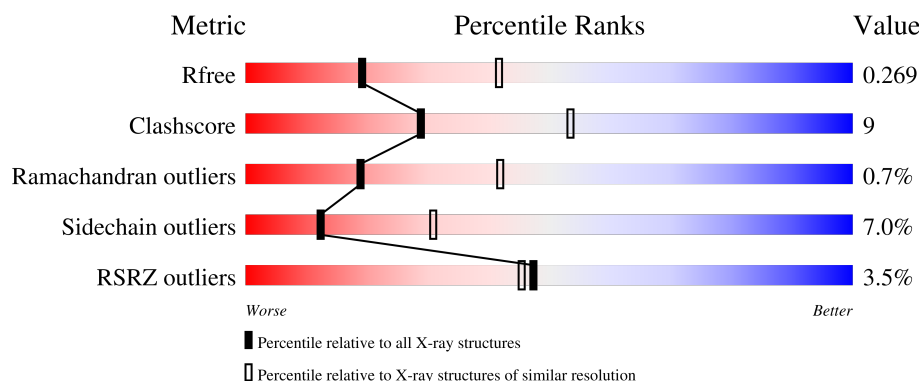
# 1 Overall quality at a glance

The following experimental techniques were used to determine the structure:

*X-RAY DIFFRACTION*

The reported resolution of this entry is 2.70 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))
$R_{free}$	164625	3333 (2.70-2.70)
Clashscore	180529	3684 (2.70-2.70)
Ramachandran outliers	177936	3633 (2.70-2.70)
Sidechain outliers	177891	3633 (2.70-2.70)
RSRZ outliers	164620	3333 (2.70-2.70)

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  $\geq 3$ , 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	441	
1	B	441	

## 2 Entry composition

There are 2 unique types of molecules in this entry. The entry contains 6273 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 Legumain.

Mol	Chain	Residues	Atoms					ZeroOcc	AltConf	Trace
1	A	385	Total	C	N	O	S	0	0	0
			3095	1962	531	581	21			
1	B	385	Total	C	N	O	S	0	0	0
			3095	1962	531	581	21			

There are 14 discrepancies between the modelled and reference sequences:

Chain	Residue	Modelled	Actual	Comment	Reference
A	233	ALA	ASP	engineered mutation	UNP O89017
A	436	HIS	-	expression tag	UNP O89017
A	437	HIS	-	expression tag	UNP O89017
A	438	HIS	-	expression tag	UNP O89017
A	439	HIS	-	expression tag	UNP O89017
A	440	HIS	-	expression tag	UNP O89017
A	441	HIS	-	expression tag	UNP O89017
B	233	ALA	ASP	engineered mutation	UNP O89017
B	436	HIS	-	expression tag	UNP O89017
B	437	HIS	-	expression tag	UNP O89017
B	438	HIS	-	expression tag	UNP O89017
B	439	HIS	-	expression tag	UNP O89017
B	440	HIS	-	expression tag	UNP O89017
B	441	HIS	-	expression tag	UNP O89017

- Molecule 2 is water.

Mol	Chain	Residues	Atoms		ZeroOcc	AltConf
2	A	45	Total	O	0	0
			45	45		
2	B	38	Total	O	0	0
			38	38		



## 4 Data and refinement statistics

Property	Value	Source
Space group	P 1 21 1	Depositor
Cell constants a, b, c, $\alpha$ , $\beta$ , $\gamma$	51.96Å 163.36Å 59.28Å 90.00° 104.32° 90.00°	Depositor
Resolution (Å)	43.58 – 2.70 43.58 – 2.70	Depositor EDS
% Data completeness (in resolution range)	91.0 (43.58-2.70) 87.2 (43.58-2.70)	Depositor EDS
$R_{merge}$	(Not available)	Depositor
$R_{sym}$	(Not available)	Depositor
$\langle I/\sigma(I) \rangle$ <sup>1</sup>	4.29 (at 2.69Å)	Xtriage
Refinement program	PHENIX (phenix.refine: 1.7.3_928)	Depositor
R, $R_{free}$	0.217 , 0.275 0.212 , 0.269	Depositor DCC
$R_{free}$ test set	1225 reflections (5.10%)	wwPDB-VP
Wilson B-factor (Å <sup>2</sup> )	20.7	Xtriage
Anisotropy	0.049	Xtriage
Bulk solvent $k_{sol}$ (e/Å <sup>3</sup> ), $B_{sol}$ (Å <sup>2</sup> )	0.27 , 30.9	EDS
L-test for twinning <sup>2</sup>	$\langle  L  \rangle = 0.48$ , $\langle L^2 \rangle = 0.32$	Xtriage
Estimated twinning fraction	No twinning to report.	Xtriage
$F_o, F_c$ correlation	0.89	EDS
Total number of atoms	6273	wwPDB-VP
Average B, all atoms (Å <sup>2</sup> )	29.0	wwPDB-VP

Xtriage's analysis on translational NCS is as follows: *The largest off-origin peak in the Patterson function is 5.27% of the height of the origin peak. No significant pseudotranslation is detected.*

<sup>1</sup>Intensities estimated from amplitudes.

<sup>2</sup>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

### 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	0.24	0/3174	0.45	1/4309 (0.0%)
1	B	0.23	0/3174	0.43	0/4309
All	All	0.24	0/6348	0.44	1/8618 (0.0%)

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	1

There are no bond length outliers.

All (1) bond angle outliers are listed below:

Mol	Chain	Res	Type	Atoms	Z	Observed(°)	Ideal(°)
1	A	140	ARG	NE-CZ-NH1	5.74	123.17	120.30

There are no chirality outliers.

All (1) planarity outliers are listed below:

Mol	Chain	Res	Type	Group
1	B	431	CYS	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	3095	0	2998	57	0
1	B	3095	0	2998	49	0
2	A	45	0	0	3	0
2	B	38	0	0	5	0
All	All	6273	0	5996	105	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 9.

All (105) 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:193:SER:HB2	1:B:210:THR:HG23	1.61	0.80
1:B:254:HIS:HB2	1:B:278:SER:HB2	1.69	0.71
1:B:349:LYS:HG2	1:B:353:LYS:HE2	1.76	0.68
1:B:39:SER:OG	1:B:149:ASP:OD2	2.06	0.67
1:A:223:TYR:HE1	1:A:316:ILE:HG23	1.60	0.66
1:B:191:CYS:SG	2:B:506:HOH:O	2.53	0.66
1:B:108:GLU:OE2	1:B:160:ASN:ND2	2.29	0.66
1:A:426:ALA:O	1:A:430:VAL:HG12	1.98	0.64
1:B:149:ASP:CG	1:B:150:HIS:H	2.00	0.64
1:A:190:ALA:O	1:A:193:SER:OG	2.15	0.63
1:A:212:ALA:HB1	1:A:216:GLU:HB3	1.80	0.62
1:B:387:HIS:NE2	1:B:428:ASP:OD1	2.22	0.62
1:A:312:VAL:O	1:A:316:ILE:HG13	2.01	0.61
1:A:261:LYS:NZ	2:A:524:HOH:O	2.29	0.60
1:B:427:MET:O	1:B:431:CYS:N	2.29	0.58
1:B:430:VAL:O	1:B:432:LEU:N	2.36	0.58
1:B:190:ALA:O	1:B:193:SER:OG	2.22	0.57
1:A:351:VAL:HA	1:A:354:ILE:HD12	1.87	0.56
1:A:58:ILE:HG23	1:A:63:ILE:HB	1.86	0.56
1:B:416:ALA:O	1:B:418:TYR:N	2.40	0.55
1:B:90:ASN:ND2	1:B:231:LEU:O	2.40	0.54
1:B:69:ILE:HG13	1:B:133:LYS:HD2	1.91	0.54
1:A:157:VAL:HG21	1:A:404:LEU:HD11	1.90	0.53
1:A:184:MET:HB3	1:A:206:VAL:HG22	1.91	0.53
1:B:184:MET:HB3	1:B:206:VAL:HG22	1.90	0.52
1:A:312:VAL:HG12	1:A:316:ILE:HD11	1.90	0.52
1:A:343:ALA:O	1:A:347:ILE:HG12	2.10	0.52
1:A:121:GLY:HA2	1:A:134:VAL:HB	1.91	0.52
1:A:265:ASN:ND2	2:A:516:HOH:O	2.44	0.52
1:B:379:ASP:N	1:B:379:ASP:OD1	2.43	0.51

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Atom-1	Atom-2	Interatomic distance (Å)	Clash overlap (Å)
1:A:91:ARG:HG3	1:A:94:GLY:HA3	1.92	0.50
1:B:315:THR:O	1:B:319:ARG:HG2	2.11	0.50
1:A:155:ILE:N	1:A:196:MET:HE1	2.27	0.50
1:A:312:VAL:HB	1:A:313:PRO:HD3	1.93	0.50
1:B:330:SER:O	1:B:334:ILE:HG12	2.11	0.50
1:B:182:GLN:HG2	1:B:183:LYS:HD2	1.94	0.50
1:A:354:ILE:CG1	1:A:430:VAL:HG11	2.42	0.50
1:A:358:LEU:HD23	1:A:422:ARG:HD3	1.93	0.49
1:A:348:GLU:O	1:A:352:HIS:ND1	2.46	0.49
1:B:92:PRO:HD3	1:B:222:TYR:CG	2.48	0.49
1:B:47:HIS:HD2	1:B:148:THR:OG1	1.96	0.48
1:B:274:ASN:ND2	2:B:505:HOH:O	2.47	0.48
1:B:89:ILE:HG22	1:B:231:LEU:HD13	1.96	0.48
1:A:140:ARG:CG	1:A:140:ARG:HH11	2.27	0.48
1:B:239:TRP:HB3	1:B:260:VAL:HG21	1.96	0.47
1:B:352:HIS:O	1:B:356:SER:N	2.46	0.47
1:B:71:MET:HG2	1:B:105:TYR:HB2	1.97	0.47
1:B:169:ASN:ND2	2:B:511:HOH:O	2.31	0.47
1:A:169:ASN:OD1	2:A:508:HOH:O	2.20	0.47
1:A:354:ILE:HG12	1:A:430:VAL:HG11	1.97	0.47
1:B:184:MET:HE3	1:B:184:MET:HB2	1.60	0.46
1:B:203:ASP:OD1	1:B:203:ASP:N	2.44	0.46
1:B:180:MET:HE3	1:B:180:MET:HB3	1.84	0.46
1:A:184:MET:HE3	1:A:184:MET:HB2	1.68	0.46
1:A:88:VAL:HB	1:A:98:TYR:HB2	1.97	0.46
1:A:33:VAL:HG22	1:A:144:PHE:HB3	1.98	0.46
1:A:71:MET:HG2	1:A:105:TYR:HB2	1.98	0.46
1:B:48:GLN:NE2	2:B:504:HOH:O	2.44	0.46
1:A:140:ARG:HH11	1:A:140:ARG:HB2	1.81	0.45
1:A:149:ASP:CG	1:A:150:HIS:N	2.70	0.45
1:B:252:THR:HG23	1:B:254:HIS:H	1.82	0.45
1:A:55:TYR:CE2	1:A:101:VAL:HA	2.52	0.45
1:A:65:ASP:HA	1:A:68:ILE:HD12	1.99	0.45
1:A:326:ASP:O	1:A:330:SER:OG	2.28	0.45
1:A:140:ARG:HH11	1:A:140:ARG:CB	2.30	0.44
1:B:164:HIS:CE1	1:B:382:GLN:HA	2.53	0.44
1:A:52:CYS:HB3	1:A:97:VAL:O	2.18	0.44
1:B:168:LEU:O	1:B:172:ILE:HG12	2.16	0.44
1:B:201:PRO:HB2	1:B:203:ASP:OD1	2.18	0.44
1:A:92:PRO:HD3	1:A:222:TYR:CG	2.53	0.44
1:B:149:ASP:CG	1:B:150:HIS:N	2.69	0.44

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Atom-1	Atom-2	Interatomic distance (Å)	Clash overlap (Å)
1:B:207:TYR:HB2	1:B:277:ILE:HB	2.00	0.44
1:B:175:MET:HA	1:B:180:MET:HG3	2.00	0.43
1:A:126:VAL:HG13	1:A:132:GLY:HA2	2.00	0.43
1:A:265:ASN:OD1	1:A:265:ASN:N	2.51	0.43
1:B:173:ARG:HD3	1:B:173:ARG:HA	1.67	0.43
1:A:131:SER:HB3	1:B:179:LYS:NZ	2.33	0.43
1:A:316:ILE:HG13	1:A:316:ILE:H	1.58	0.42
1:A:57:ILE:O	1:A:61:ASN:ND2	2.41	0.42
1:A:149:ASP:OD1	1:A:157:VAL:HB	2.18	0.42
1:A:340:PHE:O	1:A:344:ARG:HB2	2.19	0.42
1:B:89:ILE:HD13	1:B:89:ILE:HA	1.76	0.42
1:A:171:THR:O	1:A:175:MET:HG3	2.19	0.42
1:A:48:GLN:HG3	1:A:76:ILE:HG13	2.02	0.42
1:A:210:THR:OG1	1:A:270:MET:HB2	2.20	0.42
1:A:239:TRP:HB3	1:A:260:VAL:HG21	2.02	0.42
1:B:204:ILE:HD12	1:B:204:ILE:HA	1.86	0.41
1:B:88:VAL:HB	1:B:98:TYR:HB2	2.01	0.41
1:A:149:ASP:CG	1:A:150:HIS:H	2.24	0.41
1:A:152:ALA:HB2	1:A:404:LEU:HD22	2.02	0.41
1:A:65:ASP:O	1:A:133:LYS:NZ	2.53	0.41
1:A:46:ARG:HD3	1:A:220:ALA:CB	2.51	0.41
1:A:192:GLU:O	1:A:195:SER:OG	2.32	0.41
1:A:348:GLU:HB3	1:A:406:TYR:OH	2.21	0.41
1:A:395:TRP:HA	1:A:400:TYR:O	2.20	0.41
1:B:200:LEU:HD21	1:B:206:VAL:HG12	2.03	0.41
1:B:340:PHE:O	1:B:344:ARG:HB2	2.21	0.41
1:B:430:VAL:C	1:B:432:LEU:H	2.24	0.41
1:B:310:PRO:HD3	2:B:506:HOH:O	2.21	0.40
1:B:271:GLN:HG2	1:B:275:LYS:HE3	2.03	0.40
1:A:219:TYR:HB2	1:A:266:THR:HG21	2.03	0.40
1:B:405:ARG:O	1:B:408:TYR:HD2	2.04	0.40
1:A:124:GLU:HA	1:A:127:LYS:HG2	2.03	0.40
1:A:234:TRP:HA	1:A:234:TRP:CE3	2.56	0.40
1:A:347:ILE:O	1:A:351:VAL:HG23	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	381/441 (86%)	367 (96%)	12 (3%)	2 (0%)	25	49
1	B	381/441 (86%)	359 (94%)	19 (5%)	3 (1%)	16	38
All	All	762/882 (86%)	726 (95%)	31 (4%)	5 (1%)	19	42

All (5) Ramachandran outliers are listed below:

Mol	Chain	Res	Type
1	A	417	PRO
1	B	431	CYS
1	B	432	LEU
1	A	46	ARG
1	B	214	PRO

### 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	342/386 (89%)	322 (94%)	20 (6%)	17	39
1	B	342/386 (89%)	314 (92%)	28 (8%)	9	23
All	All	684/772 (89%)	636 (93%)	48 (7%)	12	31

All (48) residues with a non-rotameric sidechain are listed below:

Mol	Chain	Res	Type
1	A	89	ILE

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Mol	Chain	Res	Type
1	A	91	ARG
1	A	106	THR
1	A	126	VAL
1	A	140	ARG
1	A	182	GLN
1	A	183	LYS
1	A	193	SER
1	A	204	ILE
1	A	258	HIS
1	A	279	THR
1	A	331	GLN
1	A	344	ARG
1	A	353	LYS
1	A	357	LEU
1	A	358	LEU
1	A	380	CYS
1	A	404	LEU
1	A	421	ASP
1	A	432	LEU
1	B	53	HIS
1	B	76	ILE
1	B	89	ILE
1	B	91	ARG
1	B	97	VAL
1	B	101	VAL
1	B	106	THR
1	B	173	ARG
1	B	180	MET
1	B	183	LYS
1	B	193	SER
1	B	227	ARG
1	B	245	VAL
1	B	252	THR
1	B	266	THR
1	B	271	GLN
1	B	279	THR
1	B	289	LYS
1	B	291	ARG
1	B	296	ILE
1	B	301	VAL
1	B	331	GLN
1	B	344	ARG

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Mol	Chain	Res	Type
1	B	346	VAL
1	B	348	GLU
1	B	356	SER
1	B	399	THR
1	B	401	GLU

Sometimes sidechains can be flipped to improve hydrogen bonding and reduce clashes. All (2) such sidechains are listed below:

Mol	Chain	Res	Type
1	B	47	HIS
1	B	164	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, 95<sup>th</sup> 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 <sup>2</sup> )	Q<0.9
1	A	385/441 (87%)	0.14	11 (2%) 54 52	3, 25, 59, 97	0
1	B	385/441 (87%)	0.23	16 (4%) 41 39	5, 28, 61, 103	0
All	All	770/882 (87%)	0.19	27 (3%) 47 45	3, 26, 61, 103	0

All (27) RSRZ outliers are listed below:

Mol	Chain	Res	Type	RSRZ
1	B	432	LEU	7.5
1	B	433	SER	6.6
1	A	432	LEU	5.3
1	A	433	SER	3.5
1	B	405	ARG	3.1
1	A	398	VAL	2.8
1	B	417	PRO	2.8
1	B	422	ARG	2.7
1	B	348	GLU	2.7
1	B	415	GLU	2.7
1	B	328	LYS	2.6
1	B	379	ASP	2.6
1	A	149	ASP	2.6
1	B	401	GLU	2.6
1	A	401	GLU	2.5
1	A	431	CYS	2.5
1	A	325	ASN	2.5
1	A	327	VAL	2.4
1	B	430	VAL	2.4
1	B	254	HIS	2.3
1	A	289	LYS	2.3
1	B	398	VAL	2.3
1	A	39	SER	2.3
1	B	423	ILE	2.2

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Mol	Chain	Res	Type	RSRZ
1	B	225	GLU	2.1
1	A	399	THR	2.1
1	B	108	GLU	2.1

## 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 monosaccharides 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.