Full wwPDB NMR Structure Validation Report (i)

Jun 15, 2024 – 01:37 PM EDT

PDB ID	:	2K3C
BMRB ID	:	15747
Title	:	Structural and Functional Characterization of TM IX of the NHE1 Isoform of the Na+/H+ Exchanger
Authors	:	Reddy, T.; Ding, J.; Li, X.; Sykes, B.D.; Fliegel, L.; Rainey, J.K.
Deposited on	:	2008-05-01

This is a Full wwPDB NMR 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/NMRValidationReportHelp
with specific help available everywhere you see the (i) 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 (1)) were used in the production of this report:

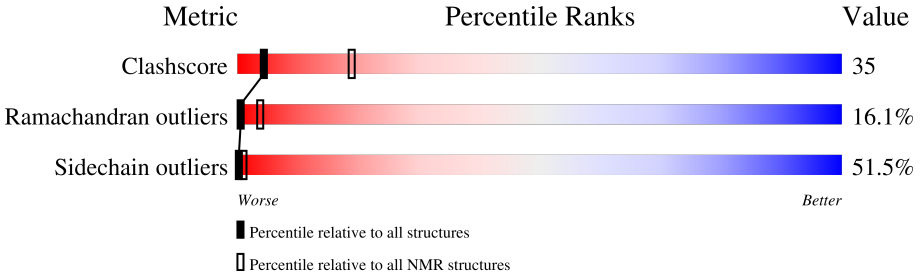
MolProbity	:	4.02b-467
Mogul	:	2022.3.0, CSD as543be (2022)
Percentile statistics	:	20191225.v01 (using entries in the PDB archive December 25th 2019)
wwPDB-RCI	:	v_1n_11_5_13_A (Berjanski et al., 2005)
PANAV	:	Wang et al. (2010)
wwPDB-ShiftChecker	:	v1.2
Ideal geometry (proteins)	:	Engh & Huber (2001)
Ideal geometry (DNA, RNA)	:	Parkinson et al. (1996)
Validation Pipeline (wwPDB-VP)	:	2.37.1

1 Overall quality at a glance (i)

The following experimental techniques were used to determine the structure:
SOLUTION NMR

The overall completeness of chemical shifts assignment is 73%.

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)	NMR archive (#Entries)
Clashscore	158937	12864
Ramachandran outliers	154571	11451
Sidechain outliers	154315	11428

The table below summarises the geometric issues observed across the polymeric chains and their fit to the experimental data. The red, orange, yellow and green segments indicate the fraction of residues that contain outliers for >=3, 2, 1 and 0 types of geometric quality criteria. A cyan segment indicates the fraction of residues that are not part of the well-defined cores, and 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 <=5%

Mol	Chain	Length	Quality of chain
1	A	33	12% 27% 9% 6% 45%

2 Ensemble composition and analysis (i)

This entry contains 40 models. Model 19 is the overall representative, medoid model (most similar to other models). The authors have identified model 1 as representative, based on the following criterion: *lowest energy*.

The following residues are included in the computation of the global validation metrics.

Well-defined (core) protein residues			
Well-defined core	**Residue range (total)**	**Backbone RMSD (Å)**	**Medoid model**
1	A:337-A:354 (18)	1.35	19

Ill-defined regions of proteins are excluded from the global statistics.

Ligands and non-protein polymers are included in the analysis.

The models can be grouped into 3 clusters and 1 single-model cluster was found.

Cluster number	Models
1	1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 15, 20, 22, 25, 27, 38
2	12, 13, 16, 17, 18, 19, 21, 28, 31, 33, 36, 39, 40
3	14, 23, 24, 26, 29, 30, 32, 34, 35, 37
Single-model clusters	11

3 Entry composition (i)

There is only 1 type of molecule in this entry. The entry contains 502 atoms, of which 261 are hydrogens and 0 are deuteriums.

- Molecule 1 is a protein called TMIX peptide.

Mol	Chain	Residues	Atoms						Trace
			Total	C	H	N	O	S	
1	A	33	502	158	261	40	40	3	1

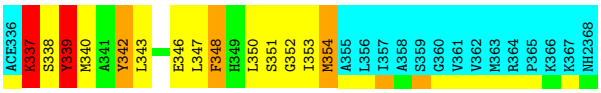
4 Residue-property plots (i)

4.1 Average score per residue in the NMR ensemble

These plots are provided for all protein, RNA, DNA and oligosaccharide chains in the entry. The first graphic is the same as shown in the summary in section 1 of this report. The second graphic shows the sequence where residues are colour-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. Stretches of 2 or more consecutive residues without any outliers are shown as green connectors. Residues which are classified as ill-defined in the NMR ensemble, are shown in cyan with an underline colour-coded according to the previous scheme. Residues which were present in the experimental sample, but not modelled in the final structure are shown in grey.

• Molecule 1: TMIX peptide

Chain A: 12% 27% 9% 6% 45%



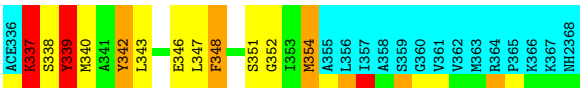
4.2 Scores per residue for each member of the ensemble

Colouring as in section 4.1 above.

4.2.1 Score per residue for model 1

• Molecule 1: TMIX peptide

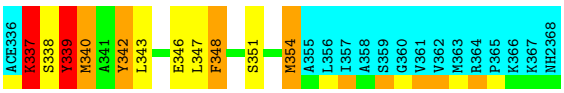
Chain A: 18% 21% 9% 6% 45%



4.2.2 Score per residue for model 2

• Molecule 1: TMIX peptide

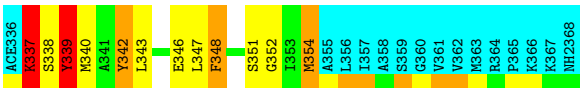
Chain A: 21% 15% 12% 6% 45%



4.2.3 Score per residue for model 3

- Molecule 1: TMIX peptide

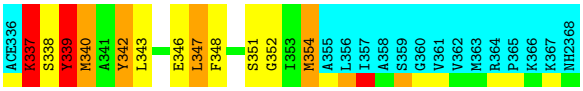
Chain A: 18% 21% 9% 6% 45%



4.2.4 Score per residue for model 4

- Molecule 1: TMIX peptide

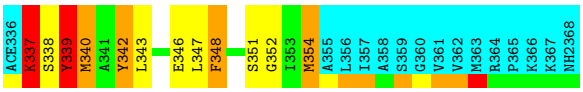
Chain A: 18% 18% 12% 6% 45%



4.2.5 Score per residue for model 5

- Molecule 1: TMIX peptide

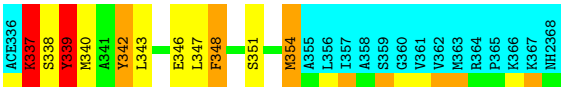
Chain A: 18% 18% 12% 6% 45%



4.2.6 Score per residue for model 6

- Molecule 1: TMIX peptide

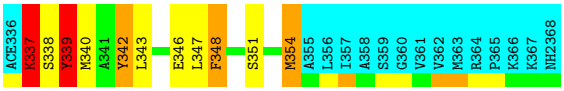
Chain A: 21% 18% 9% 6% 45%



4.2.7 Score per residue for model 7

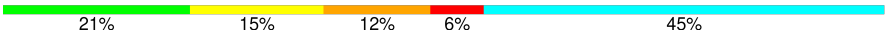
- Molecule 1: TMIX peptide

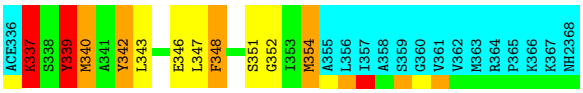
Chain A: 21% 18% 9% 6% 45%



4.2.8 Score per residue for model 8

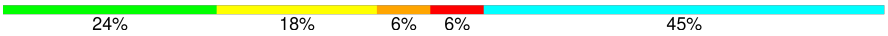
- Molecule 1: TMIX peptide

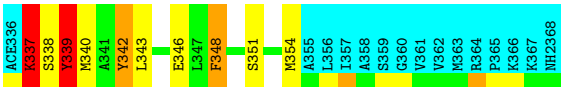
Chain A: 



4.2.9 Score per residue for model 9

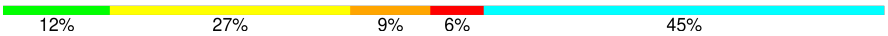
- Molecule 1: TMIX peptide

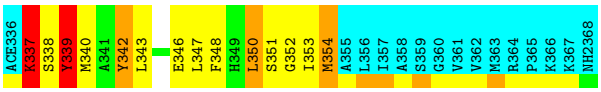
Chain A: 



4.2.10 Score per residue for model 10

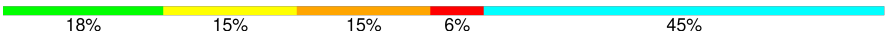
- Molecule 1: TMIX peptide

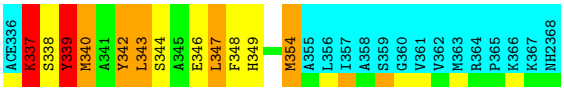
Chain A: 



4.2.11 Score per residue for model 11

- Molecule 1: TMIX peptide

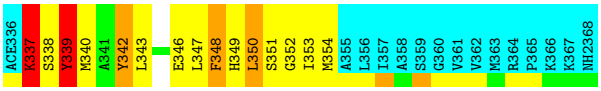
Chain A: 



4.2.12 Score per residue for model 12

- Molecule 1: TMIX peptide

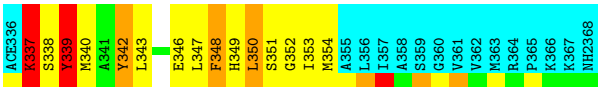
Chain A: 9% 30% 9% 6% 45%



4.2.13 Score per residue for model 13

- Molecule 1: TMIX peptide

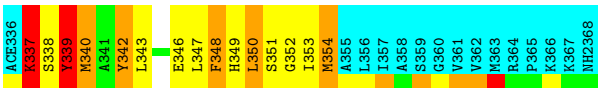
Chain A: 9% 30% 9% 6% 45%



4.2.14 Score per residue for model 14

- Molecule 1: TMIX peptide

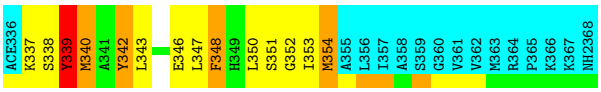
Chain A: 9% 24% 15% 6% 45%



4.2.15 Score per residue for model 15

- Molecule 1: TMIX peptide

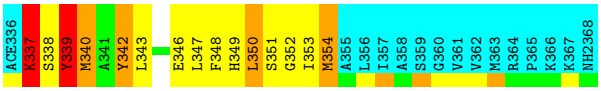
Chain A: 12% 27% 12% • 45%



4.2.16 Score per residue for model 16

- Molecule 1: TMIX peptide

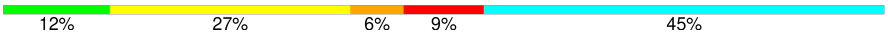
Chain A: 9% 27% 12% 6% 45%

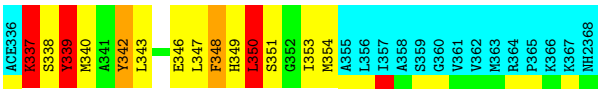


4.2.17 Score per residue for model 17

- Molecule 1: TMIX peptide

Chain A:

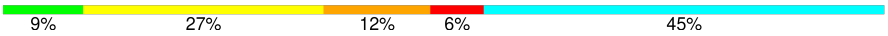


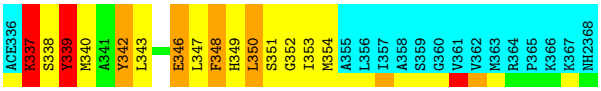


4.2.18 Score per residue for model 18

- Molecule 1: TMIX peptide

Chain A:

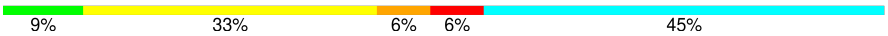


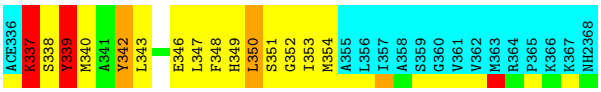


4.2.19 Score per residue for model 19 (medoid)

- Molecule 1: TMIX peptide

Chain A:

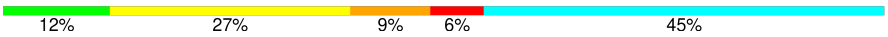


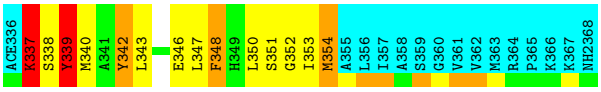


4.2.20 Score per residue for model 20

- Molecule 1: TMIX peptide

Chain A:

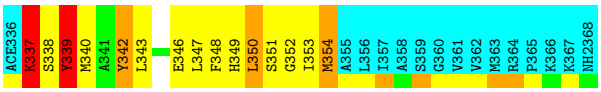




4.2.21 Score per residue for model 21

- Molecule 1: TMIX peptide

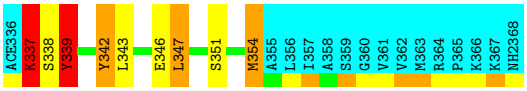
Chain A: 9% 30% 9% 6% 45%



4.2.22 Score per residue for model 22

- Molecule 1: TMIX peptide

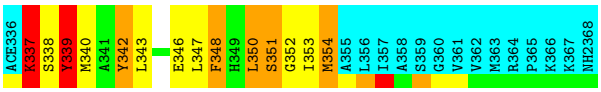
Chain A: 27% 12% 9% 6% 45%



4.2.23 Score per residue for model 23

- Molecule 1: TMIX peptide

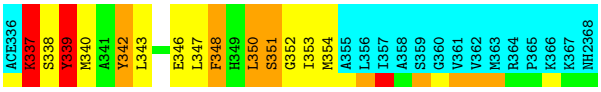
Chain A: 12% 21% 15% 6% 45%



4.2.24 Score per residue for model 24

- Molecule 1: TMIX peptide

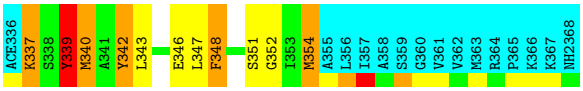
Chain A: 12% 24% 12% 6% 45%



4.2.25 Score per residue for model 25

- Molecule 1: TMIX peptide

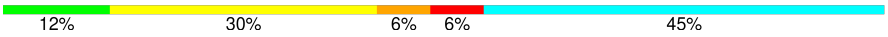
Chain A: 21% 15% 15% • 45%

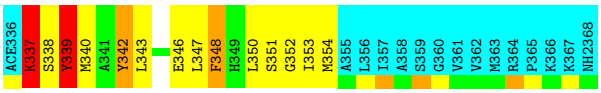


4.2.26 Score per residue for model 26

- Molecule 1: TMIX peptide

Chain A:

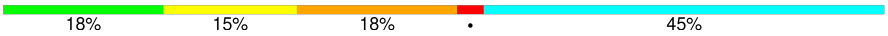


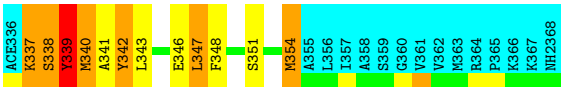


4.2.27 Score per residue for model 27

- Molecule 1: TMIX peptide

Chain A:

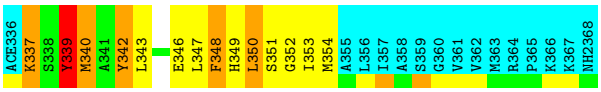




4.2.28 Score per residue for model 28

- Molecule 1: TMIX peptide

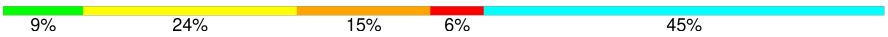
Chain A:

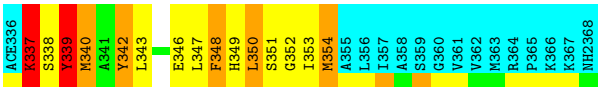


4.2.29 Score per residue for model 29

- Molecule 1: TMIX peptide

Chain A:

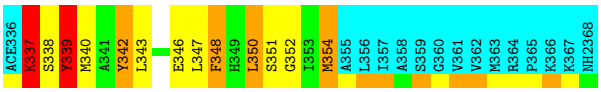




4.2.30 Score per residue for model 30

- Molecule 1: TMIX peptide

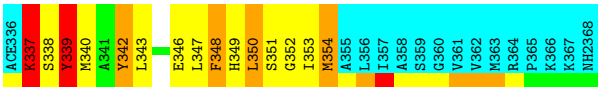
Chain A: 15% 21% 12% 6% 45%



4.2.31 Score per residue for model 31

- Molecule 1: TMIX peptide

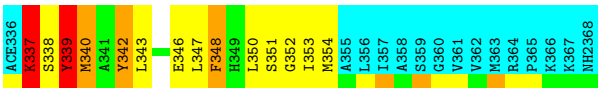
Chain A: 9% 27% 12% 6% 45%



4.2.32 Score per residue for model 32

- Molecule 1: TMIX peptide

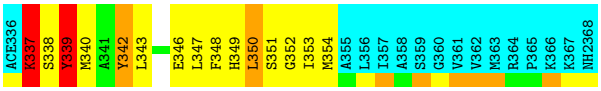
Chain A: 12% 27% 9% 6% 45%



4.2.33 Score per residue for model 33

- Molecule 1: TMIX peptide

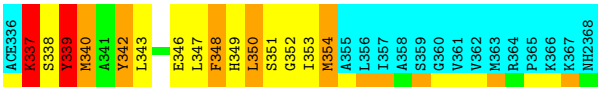
Chain A: 9% 33% 6% 6% 45%



4.2.34 Score per residue for model 34

- Molecule 1: TMIX peptide

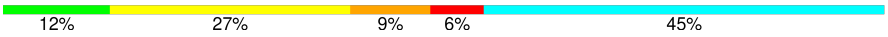
Chain A: 9% 24% 15% 6% 45%

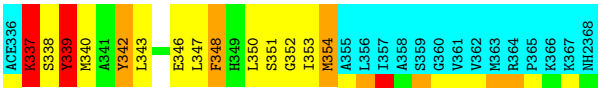


4.2.35 Score per residue for model 35

- Molecule 1: TMIX peptide

Chain A:

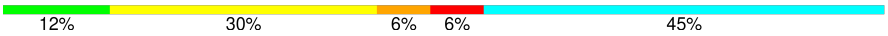


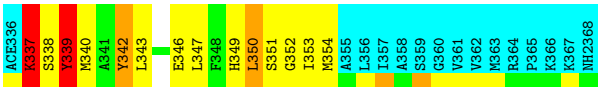


4.2.36 Score per residue for model 36

- Molecule 1: TMIX peptide

Chain A:

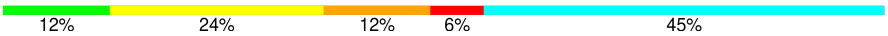


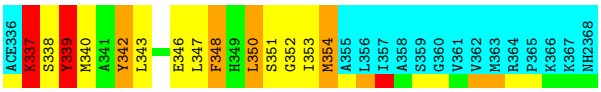


4.2.37 Score per residue for model 37

- Molecule 1: TMIX peptide

Chain A:

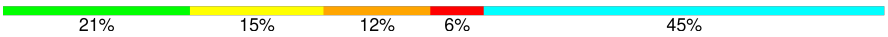


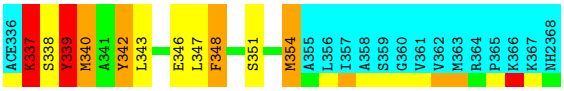


4.2.38 Score per residue for model 38

- Molecule 1: TMIX peptide

Chain A:

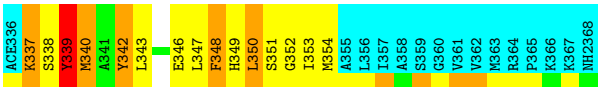




4.2.39 Score per residue for model 39

- Molecule 1: TMIX peptide

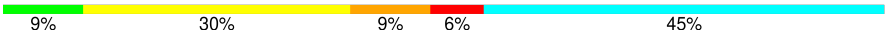
Chain A:

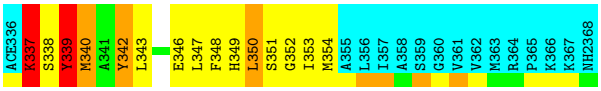


4.2.40 Score per residue for model 40

- Molecule 1: TMIX peptide

Chain A:





5 Refinement protocol and experimental data overview (i)

The models were refined using the following method: *simulated annealing*.

Of the 100 calculated structures, 40 were deposited, based on the following criterion: *structures with the lowest energy*.

The following table shows the software used for structure solution, optimisation and refinement.

Software name	Classification	Version
X-PLOR NIH	structure solution	2.18
X-PLOR NIH	refinement	2.18

The following table shows chemical shift validation statistics as aggregates over all chemical shift files. Detailed validation can be found in section 7 of this report.

Chemical shift file(s)	working_cs.cif
Number of chemical shift lists	1
Total number of shifts	332
Number of shifts mapped to atoms	331
Number of unparsed shifts	0
Number of shifts with mapping errors	1
Number of shifts with mapping warnings	0
Assignment completeness (well-defined parts)	73%

6 Model quality (i)

6.1 Standard geometry (i)

Bond lengths and bond angles in the following residue types are not validated in this section: NH2, ACE

There are no covalent bond-length or bond-angle outliers.

There are no bond-length outliers.

There are no bond-angle outliers.

There are no chirality outliers.

There are no planarity outliers.

6.2 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 each 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 averaged over the ensemble.

Mol	Chain	Non-H	H(model)	H(added)	Clashes
1	A	143	143	143	10±2
All	All	5720	5720	5720	404

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 35.

All unique clashes are listed below, sorted by their clash magnitude.

Atom-1	Atom-2	Clash(Å)	Distance(Å)	Models	
				Worst	Total
1:A:350:LEU:HD12	1:A:350:LEU:H	0.69	1.48	24	6
1:A:350:LEU:HD23	1:A:350:LEU:N	0.68	2.04	21	4
1:A:350:LEU:HD12	1:A:350:LEU:N	0.68	2.03	19	5
1:A:342:TYR:CG	1:A:343:LEU:N	0.65	2.65	16	39
1:A:339:TYR:CD1	1:A:339:TYR:N	0.64	2.65	20	40
1:A:349:HIS:CD2	1:A:350:LEU:HD23	0.64	2.28	33	6
1:A:348:PHE:CD1	1:A:348:PHE:N	0.62	2.67	14	31
1:A:337:LYS:NZ	1:A:337:LYS:N	0.61	2.49	39	1
1:A:348:PHE:N	1:A:348:PHE:CD1	0.60	2.68	13	7
1:A:350:LEU:HD23	1:A:350:LEU:H	0.60	1.55	33	1
1:A:343:LEU:C	1:A:343:LEU:HD12	0.60	2.17	33	3
1:A:338:SER:O	1:A:342:TYR:N	0.59	2.36	20	1

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Atom-1	Atom-2	Clash(Å)	Distance(Å)	Models	
				Worst	Total
1:A:350:LEU:O	1:A:352:GLY:N	0.58	2.36	32	25
1:A:350:LEU:H	1:A:350:LEU:HD23	0.58	1.57	16	1
1:A:337:LYS:N	1:A:339:TYR:CZ	0.58	2.72	22	5
1:A:349:HIS:CG	1:A:350:LEU:N	0.58	2.72	17	10
1:A:337:LYS:N	1:A:337:LYS:CD	0.56	2.69	11	31
1:A:350:LEU:N	1:A:350:LEU:CD1	0.55	2.69	24	5
1:A:350:LEU:H	1:A:350:LEU:CD2	0.55	2.14	33	2
1:A:350:LEU:N	1:A:350:LEU:HD12	0.54	2.17	17	1
1:A:350:LEU:O	1:A:353:ILE:N	0.54	2.41	32	5
1:A:349:HIS:CD2	1:A:350:LEU:CD2	0.54	2.90	21	4
1:A:349:HIS:CG	1:A:350:LEU:H	0.53	2.21	17	1
1:A:350:LEU:N	1:A:350:LEU:CD2	0.53	2.69	21	2
1:A:350:LEU:H	1:A:350:LEU:CD1	0.53	2.15	19	1
1:A:348:PHE:C	1:A:350:LEU:HD12	0.53	2.24	40	2
1:A:350:LEU:CD1	1:A:350:LEU:H	0.53	2.16	40	1
1:A:337:LYS:O	1:A:338:SER:CB	0.53	2.57	27	1
1:A:349:HIS:O	1:A:351:SER:N	0.52	2.43	17	1
1:A:350:LEU:O	1:A:354:MET:N	0.51	2.39	29	6
1:A:342:TYR:C	1:A:342:TYR:CD1	0.51	2.84	11	1
1:A:350:LEU:O	1:A:354:MET:CG	0.50	2.60	26	10
1:A:347:LEU:O	1:A:354:MET:SD	0.50	2.70	11	15
1:A:337:LYS:N	1:A:339:TYR:CE1	0.49	2.81	27	1
1:A:342:TYR:CD1	1:A:342:TYR:C	0.49	2.86	6	35
1:A:338:SER:C	1:A:339:TYR:CG	0.48	2.87	29	35
1:A:340:MET:C	1:A:340:MET:SD	0.46	2.94	39	12
1:A:349:HIS:C	1:A:351:SER:N	0.46	2.68	17	1
1:A:354:MET:C	1:A:354:MET:SD	0.45	2.95	17	2
1:A:337:LYS:N	1:A:339:TYR:OH	0.45	2.49	27	2
1:A:340:MET:C	1:A:343:LEU:CD2	0.45	2.84	11	1
1:A:343:LEU:H	1:A:343:LEU:HD23	0.45	1.72	11	1
1:A:354:MET:SD	1:A:354:MET:C	0.45	2.96	22	10
1:A:348:PHE:C	1:A:350:LEU:H	0.45	2.16	34	10
1:A:338:SER:O	1:A:339:TYR:C	0.45	2.55	20	1
1:A:350:LEU:C	1:A:354:MET:SD	0.44	2.96	36	1
1:A:337:LYS:N	1:A:337:LYS:HZ3	0.44	2.10	39	1
1:A:338:SER:O	1:A:339:TYR:O	0.43	2.36	20	1
1:A:337:LYS:CD	1:A:337:LYS:C	0.43	2.87	28	1
1:A:339:TYR:CE1	1:A:340:MET:HE3	0.43	2.49	38	4
1:A:346:GLU:O	1:A:346:GLU:OE1	0.42	2.37	18	1
1:A:349:HIS:O	1:A:350:LEU:C	0.42	2.57	36	3
1:A:339:TYR:C	1:A:341:ALA:H	0.41	2.18	27	1

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Atom-1	Atom-2	Clash(Å)	Distance(Å)	Models	
				Worst	Total
1:A:351:SER:O	1:A:351:SER:OG	0.41	2.37	17	3
1:A:339:TYR:CZ	1:A:340:MET:CE	0.41	3.04	8	2
1:A:339:TYR:C	1:A:341:ALA:N	0.41	2.74	27	1

6.3 Torsion angles (i)

6.3.1 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 PDB entries followed by that with respect to all NMR entries. 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	18/33 (55%)	10±1 (54±6%)	5±1 (30±7%)	3±0 (16±2%)	0 4
All	All	720/1320 (55%)	391 (54%)	213 (30%)	116 (16%)	0 4

All 5 unique Ramachandran outliers are listed below. They are sorted by the frequency of occurrence in the ensemble.

Mol	Chain	Res	Type	Models (Total)
1	A	339	TYR	40
1	A	351	SER	38
1	A	337	LYS	36
1	A	350	LEU	1
1	A	338	SER	1

6.3.2 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 PDB entries followed by that with respect to all NMR entries. 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	15/25 (60%)	7±1 (48±6%)	8±1 (52±6%)	0 1
All	All	600/1000 (60%)	291 (48%)	309 (52%)	0 1

All 12 unique residues with a non-rotameric sidechain are listed below. They are sorted by the

frequency of occurrence in the ensemble.

Mol	Chain	Res	Type	Models (Total)
1	A	337	LYS	40
1	A	339	TYR	40
1	A	342	TYR	40
1	A	346	GLU	40
1	A	340	MET	39
1	A	348	PHE	29
1	A	354	MET	29
1	A	347	LEU	28
1	A	350	LEU	21
1	A	343	LEU	1
1	A	344	SER	1
1	A	349	HIS	1

6.3.3 RNA (i)

There are no RNA molecules in this entry.

6.4 Non-standard residues in protein, DNA, RNA chains (i)

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

6.5 Carbohydrates (i)

There are no monosaccharides in this entry.

6.6 Ligand geometry (i)

There are no ligands in this entry.

6.7 Other polymers (i)

There are no such molecules in this entry.

6.8 Polymer linkage issues (i)

There are no chain breaks in this entry.

7 Chemical shift validation (i)

The completeness of assignment taking into account all chemical shift lists is 73% for the well-defined parts and 75% for the entire structure.

7.1 Chemical shift list 1

File name: working_cs.cif

Chemical shift list name: *assigned_chem_shift_list_1*

7.1.1 Bookkeeping (i)

The following table shows the results of parsing the chemical shift list and reports the number of nuclei with statistically unusual chemical shifts.

Total number of shifts	332
Number of shifts mapped to atoms	331
Number of unparsed shifts	0
Number of shifts with mapping errors	1
Number of shifts with mapping warnings	0
Number of shift outliers (ShiftChecker)	0

The following assigned chemical shifts were not mapped to the molecules present in the coordinate file.

- No matching atom found in the structure. All 1 occurrences are reported below.

List ID	Chain	Res	Type	Atom	Shift Data		
					Value	Uncertainty	Ambiguity
1	A	349	HIS	HD1	8.699	0.05	1

7.1.2 Chemical shift referencing (i)

The following table shows the suggested chemical shift referencing corrections.

Nucleus	# values	Correction ± precision, *ppm*	Suggested action
$^{13}C_{\alpha}$	25	0.16 ± 0.34	None needed (< 0.5 ppm)
$^{13}C_{\beta}$	25	0.82 ± 0.15	Should be applied
$^{13}C'$	0	—	None (insufficient data)
^{15}N	0	—	None (insufficient data)

7.1.3 Completeness of resonance assignments (i)

The following table shows the completeness of the chemical shift assignments for the well-defined regions of the structure. The overall completeness is 73%, i.e. 180 atoms were assigned a chemical shift out of a possible 247. 0 out of 3 assigned methyl groups (LEU and VAL) were assigned stereospecifically.

	Total	^{1}H	^{13}C	^{15}N
Backbone	49/91 (54%)	37/37 (100%)	12/36 (33%)	0/18 (0%)
Sidechain	102/121 (84%)	75/82 (91%)	27/38 (71%)	0/1 (0%)
Aromatic	29/35 (83%)	15/17 (88%)	14/17 (82%)	0/1 (0%)
Overall	180/247 (73%)	127/136 (93%)	53/91 (58%)	0/20 (0%)

The following table shows the completeness of the chemical shift assignments for the full structure. The overall completeness is 75%, i.e. 323 atoms were assigned a chemical shift out of a possible 431. 0 out of 6 assigned methyl groups (LEU and VAL) were assigned stereospecifically.

	Total	^{1}H	^{13}C	^{15}N
Backbone	88/155 (57%)	63/63 (100%)	25/62 (40%)	0/30 (0%)
Sidechain	206/241 (85%)	148/162 (91%)	58/73 (79%)	0/6 (0%)
Aromatic	29/35 (83%)	15/17 (88%)	14/17 (82%)	0/1 (0%)
Overall	323/431 (75%)	226/242 (93%)	97/152 (64%)	0/37 (0%)

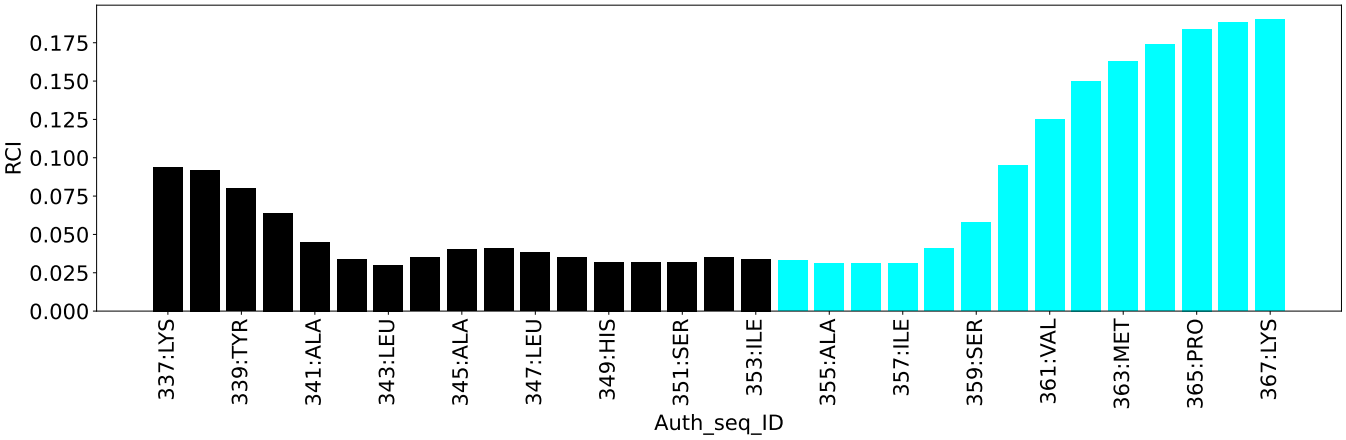
7.1.4 Statistically unusual chemical shifts (i)

There are no statistically unusual chemical shifts.

7.1.5 Random Coil Index (RCI) plots (i)

The image below reports *random coil index* values for the protein chains in the structure. The height of each bar gives a probability of a given residue to be disordered, as predicted from the available chemical shifts and the amino acid sequence. A value above 0.2 is an indication of significant predicted disorder. The colour of the bar shows whether the residue is in the well-defined core (black) or in the ill-defined residue ranges (cyan), as described in section 2 on ensemble composition.If well-defined core and ill-defined regions are not identified then it is shown as gray bars.

Random coil index (RCI) for chain A:


RCI
0.175
0.150
0.125
0.100
0.075
0.050
0.025
0.000
337:LYS
339:TYR
341:ALA
343:LEU
345:ALA
347:LEU
349:HIS
351:SER
353:ILE
355:ALA
357:ILE
359:SER
361:VAL
363:MET
365:PRO
367:LYS
Auth_seq_ID