Full wwPDB NMR Structure Validation Report (i)

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Title	:	Solution Structure of a Minor and Transiently Formed State of a T4 Lysozyme Mutant
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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 (i)) were used in the production of this report:

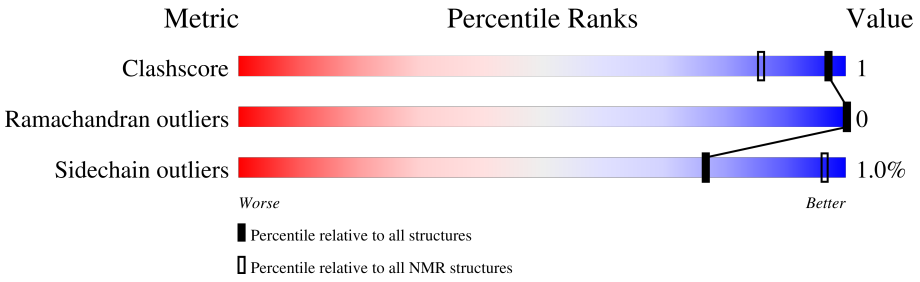
MolProbity	:	4.02b-467
Percentile statistics	:	20191225.v01 (using entries in the PDB archive December 25th 2019)
wwPDB-RCI	:	v_1n_11_5_13_A (Berjanski et al., 2005)
PANAV	:	Wang et al. (2010)
wwPDB-ShiftChecker	:	v1.2
Ideal geometry (proteins)	:	Engh & Huber (2001)
Ideal geometry (DNA, RNA)	:	Parkinson et al. (1996)
Validation Pipeline (wwPDB-VP)	:	2.36.2

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 41%.

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	164	85% • 13%

2 Ensemble composition and analysis (i)

This entry contains 10 models. Model 9 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:1-A:103, A:118-A:135, A:143-A:164 (143)	0.12	9

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 2 clusters and 1 single-model cluster was found.

Cluster number	Models
1	2, 6, 7, 8, 9
2	1, 3, 4, 5
Single-model clusters	10

3 Entry composition (i)

There is only 1 type of molecule in this entry. The entry contains 2629 atoms, of which 1326 are hydrogens and 0 are deuteriums.

- Molecule 1 is a protein called Lysozyme.

Mol	Chain	Residues	Atoms						Trace
			Total	C	H	N	O	S	
1	A	164	2629	821	1326	235	242	5	0

There are 5 discrepancies between the modelled and reference sequences:

Chain	Residue	Modelled	Actual	Comment	Reference
A	54	THR	CYS	engineered mutation	UNP P00720
A	97	ALA	CYS	engineered mutation	UNP P00720
A	99	ALA	LEU	engineered mutation	UNP P00720
A	113	ALA	GLY	engineered mutation	UNP P00720
A	119	PRO	ARG	engineered mutation	UNP P00720

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: Lysozyme

Chain A:

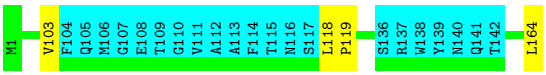
4.2 Scores per residue for each member of the ensemble

Colouring as in section 4.1 above.

4.2.1 Score per residue for model 1

• Molecule 1: Lysozyme

Chain A:



4.2.2 Score per residue for model 2

• Molecule 1: Lysozyme

Chain A:

4.2.3 Score per residue for model 3

- Molecule 1: Lysozyme

Chain A: 85% • 13%

M1 F104 Q105 M106 G107 E108 T109 G110 V111 A112 A113 F114 T115 N116 S117 L118 P119 S136 R137 W138 Y139 N140 Q141 T142 L164

4.2.4 Score per residue for model 4

- Molecule 1: Lysozyme

Chain A: 85% • 13%

M1 N101 F104 Q105 M106 G107 E108 T109 G110 V111 A112 A113 F114 T115 N116 S117 L118 P119 S136 R137 W138 Y139 N140 Q141 T142 L164

4.2.5 Score per residue for model 5

- Molecule 1: Lysozyme

Chain A: 85% • 13%

M1 F104 Q105 M106 G107 E108 T109 G110 V111 A112 A113 F114 T115 N116 S117 L118 P119 S136 R137 W138 Y139 N140 Q141 T142 L164

4.2.6 Score per residue for model 6

- Molecule 1: Lysozyme

Chain A: 85% • 13%

M1 F104 Q105 M106 G107 E108 T109 G110 V111 A112 A113 F114 T115 N116 S117 L118 P119 S136 R137 W138 Y139 N140 Q141 T142 L164

4.2.7 Score per residue for model 7

- Molecule 1: Lysozyme

Chain A: 84% • 13%

M1 V103 F104 Q105 M106 G107 E108 T109 G110 V111 A112 A113 F114 T115 N116 S117 L118 P119 L133 S136 R137 W138 Y139 N140 Q141 T142 L164

4.2.8 Score per residue for model 8

- Molecule 1: Lysozyme

Chain A: 85% • 13%

M1 F104 Q105 M106 G107 E108 T109 G110 V111 A112 A113 F114 T115 N116 S117 L118 P119 N132 S136 R137 W138 Y139 N140 Q141 T142 L164

4.2.9 Score per residue for model 9 (medoid)

- Molecule 1: Lysozyme

Chain A: 85% • 13%

M1 F104 Q105 M106 G107 E108 T109 G110 V111 A112 A113 F114 T115 N116 S117 L118 P119 S136 R137 W138 Y139 N140 Q141 T142 L164

4.2.10 Score per residue for model 10

- Molecule 1: Lysozyme

Chain A: 85% • 13%

M1 F104 Q105 M106 G107 E108 T109 G110 V111 A112 A113 F114 T115 N116 S117 L118 P119 S136 R137 W138 Y139 N140 Q141 T142 L164

5 Refinement protocol and experimental data overview (i)

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

Of the 9600 calculated structures, 10 were deposited, based on the following criterion: *Two Step Selection Criteria based on chemical shift score and Rosetta energy.*

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

Software name	**Classification**	**Version**
CS-ROSETTA	structure solution	
CS-ROSETTA	refinement	

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	960
Number of shifts mapped to atoms	960
Number of unparsed shifts	0
Number of shifts with mapping errors	0
Number of shifts with mapping warnings	0
Assignment completeness (well-defined parts)	41%

6 Model quality (i)

6.1 Standard geometry (i)

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	1135	1177	1177	2±1
All	All	11350	11770	11770	15

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 1.

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

Atom-1	Atom-2	Clash(Å)	Distance(Å)	Models	
				Worst	Total
1:A:118:LEU:N	1:A:119:PRO:CD	0.61	2.64	9	10
1:A:103:VAL:O	1:A:103:VAL:CG1	0.42	2.67	1	2
1:A:103:VAL:O	1:A:103:VAL:HG12	0.42	2.15	7	2
1:A:101:ASN:O	1:A:101:ASN:OD1	0.41	2.39	4	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	141/164 (86%)	140±0 (99±0%)	1±0 (1±0%)	0±0 (0±0%)	100	100
All	All	1410/1640 (86%)	1399 (99%)	11 (1%)	0 (0%)	100	100

There are no Ramachandran outliers.

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	119/136 (88%)	118±0 (99±0%)	1±0 (1±0%)	77	96
All	All	1190/1360 (88%)	1178 (99%)	12 (1%)	77	96

All 3 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	164	LEU	10
1	A	133	LEU	1
1	A	132	ASN	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 41% for the well-defined parts and 42% 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	960
Number of shifts mapped to atoms	960
Number of unparsed shifts	0
Number of shifts with mapping errors	0
Number of shifts with mapping warnings	0
Number of shift outliers (ShiftChecker)	0

7.1.2 Chemical shift referencing (i)

The following table shows the suggested chemical shift referencing corrections.

Nucleus	# values	Correction ± precision, *ppm*	Suggested action
$^{13}C_{\alpha}$	163	-0.53 ± 0.13	Should be checked
$^{13}C_{\beta}$	153	0.08 ± 0.08	None needed (< 0.5 ppm)
$^{13}C'$	158	-0.26 ± 0.09	None needed (< 0.5 ppm)
^{15}N	159	0.70 ± 0.30	Should be applied

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 41%, i.e. 838 atoms were assigned a chemical shift out of a possible 2021. 0 out of 23 assigned methyl groups (LEU and VAL) were assigned stereospecifically.

	Total	^{1}H	^{13}C	^{15}N
Backbone	704/715 (98%)	285/290 (98%)	281/286 (98%)	138/139 (99%)
Sidechain	134/1200 (11%)	0/778 (0%)	134/363 (37%)	0/59 (0%)

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	Total	^{1}H	^{13}C	^{15}N
Aromatic	0/106 (0%)	0/51 (0%)	0/52 (0%)	0/3 (0%)
Overall	838/2021 (41%)	285/1119 (25%)	415/701 (59%)	138/201 (69%)

The following table shows the completeness of the chemical shift assignments for the full structure. The overall completeness is 42%, i.e. 960 atoms were assigned a chemical shift out of a possible 2292. 0 out of 24 assigned methyl groups (LEU and VAL) were assigned stereospecifically.

	Total	^{1}H	^{13}C	^{15}N
Backbone	807/822 (98%)	327/334 (98%)	321/328 (98%)	159/160 (99%)
Sidechain	153/1323 (12%)	0/857 (0%)	153/400 (38%)	0/66 (0%)
Aromatic	0/147 (0%)	0/71 (0%)	0/72 (0%)	0/4 (0%)
Overall	960/2292 (42%)	327/1262 (26%)	474/800 (59%)	159/230 (69%)

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: