wwPDB NMR Structure Validation Summary Report (i)

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PDB ID	:	2LFP
Title	:	Structure of bacteriophage SPP1 gp17 protein
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This is a wwPDB NMR Structure Validation Summary Report for a publicly released PDB entry.
We welcome your comments at validation@mail.wwpdb.org
A user guide is available at
http://wwpdb.org/validation/2016/NMRValidationReportHelp
with specific help available everywhere you see the (i) symbol.

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

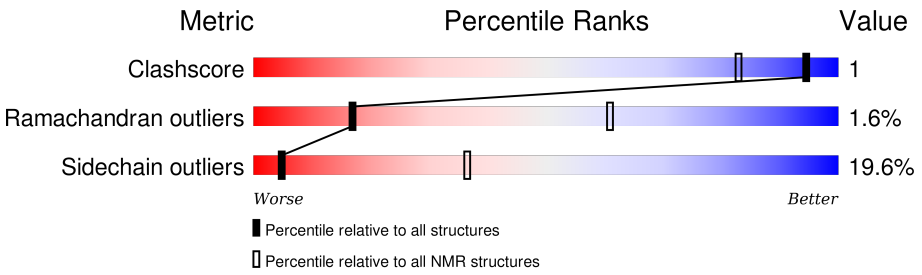
Cyrange	:	Kirchner and Güntert (2011)
NmrClust	:	Kelley et al. (1996)
MolProbity	:	4.02b-467
Mogul	:	unknown
Percentile statistics	:	20151230.v01 (using entries in the PDB archive December 30th 2015)
RCI	:	v_1n_11_5_13_A (Berjanski et al., 2005)
PANAV	:	Wang et al. (2010)
ShiftChecker	:	rb-20027457
Ideal geometry (proteins)	:	Engh & Huber (2001)
Ideal geometry (DNA, RNA)	:	Parkinson et al. (1996)
Validation Pipeline (wwPDB-VP)	:	rb-20027457

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 68%.

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	114402	11133
Ramachandran outliers	111179	9975
Sidechain outliers	111093	9958

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	139	

2 Ensemble composition and analysis (i)

This entry contains 20 models. Model 18 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:5-A:49, A:63-A:105, A:122-A:131 (98)	0.61	18

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	8, 10, 11, 12, 14, 15, 16, 17, 18, 19, 20
2	1, 4, 6, 7, 9, 13
3	2, 3
Single-model clusters	5

3 Entry composition (i)

There is only 1 type of molecule in this entry. The entry contains 2165 atoms, of which 1077 are hydrogens and 0 are deuteriums.

- Molecule 1 is a protein called Bacteriophage SPP1 complete nucleotide sequence.

Mol	Chain	Residues	Atoms						Trace
			Total	C	H	N	O	S	
1	A	139	2165	691	1077	180	213	4	0

There are 6 discrepancies between the modelled and reference sequences:

Chain	Residue	Modelled	Actual	Comment	Reference
A	-4	GLN	-	EXPRESSION TAG	UNP O48448
A	-3	GLY	-	EXPRESSION TAG	UNP O48448
A	-2	LEU	-	EXPRESSION TAG	UNP O48448
A	-1	GLN	-	EXPRESSION TAG	UNP O48448
A	200	THR	-	EXPRESSION TAG	UNP O48448
A	201	GLY	-	EXPRESSION TAG	UNP O48448

4 Residue-property plots (i)

4.1 Average score per residue in the NMR ensemble

These plots are provided for all protein, RNA and DNA 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: Bacteriophage SPP1 complete nucleotide sequence

Chain A: 54% 14% • 29%

Q-4 G-3 L-2 Q-1 T2 W3 K4 R8 A9 L10 Q11 V15 Y21 L24 N29 S34 K37 Y41 P42 Y43 S50 S51 T52 P53 F54 E55 T56 K57 S58 S59 F60 G61 E62 M63 I64 D67 F68 W71 T74 T91 Y92 K93 P94 L95 F102

K106 L107 V108 L109 A110 Q111 V112 I113 T114 D115 T116 D117 G118 V119 T120 K121 I124 F129 N132 N133 N134 T200 G201

4.2 Residue scores for the representative (medoid) model from the NMR ensemble

The representative model is number 18. Colouring as in section 4.1 above.

- Molecule 1: Bacteriophage SPP1 complete nucleotide sequence

Chain A: 52% 14% 5% 29%

Q-4 G-3 L-2 Q-1 T2 W3 K4 R8 A9 L10 Q11 K12 V15 E19 S20 Y21 L24 N29 Q30 V31 S34 K37 Y41 S50 S51 T52 P53 F54 E55 T56 K57 S58 S59 F60 G61 E62 M63 I64 D67 F68 W71 R85 V86 L87 T91 Y92

L95 E98 F102 K106 L107 V108 L109 A110 Q111 V112 I113 T114 D115 T116 D117 G118 V119 T120 K121 H122 G123 I124 N132 N133 N134 T200 G201

5 Refinement protocol and experimental data overview (i)

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

Of the 1000 calculated structures, 20 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
CNS	structure solution	
CNS	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)	2lfp_cs.str
Number of chemical shift lists	1
Total number of shifts	1092
Number of shifts mapped to atoms	1092
Number of unparsed shifts	0
Number of shifts with mapping errors	0
Number of shifts with mapping warnings	0
Assignment completeness (well-defined parts)	68%

No validations of the models with respect to experimental NMR restraints is performed at this time.

6 Model quality (i)

6.1 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 (average) 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	0.96±0.01	0±0/795 (0.0±0.0%)	1.46±0.04	8±3/1080 (0.7±0.3%)
All	All	0.96	0/15900 (0.0%)	1.46	150/21600 (0.7%)

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	Planarity
1	A	0.1±0.3	2.1±0.8
All	All	2	43

There are no bond-length outliers.

5 of 43 unique angle outliers are listed below. They are sorted according to the Z-score of the worst occurrence in the ensemble.

Mol	Chain	Res	Type	Atoms	Z	Observed(^{o})	Ideal(^{o})	Models	
								Worst	Total
1	A	41	TYR	CB-CG-CD1	10.82	127.49	121.00	19	6
1	A	41	TYR	CB-CG-CD2	-10.12	114.93	121.00	14	5
1	A	8	ARG	CB-CA-C	9.87	130.15	110.40	1	17
1	A	21	TYR	CB-CG-CD2	-8.22	116.07	121.00	11	9
1	A	10	LEU	CB-CG-CD1	8.02	124.62	111.00	12	8

All unique chiral outliers are listed below.

Mol	Chain	Res	Type	Atoms	Models (Total)
1	A	91	THR	CA	2

5 of 8 unique planar outliers are listed below. They are sorted by the frequency of occurrence in the ensemble.

Mol	Chain	Res	Type	Group	Models (Total)
1	A	41	TYR	Sidechain	12
1	A	92	TYR	Sidechain	11
1	A	43	TYR	Sidechain	7
1	A	21	TYR	Sidechain	5
1	A	102	PHE	Sidechain	4

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	777	771	771	2±2
All	All	15540	15420	15420	46

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.

5 of 35 unique clashes are listed below, sorted by their clash magnitude.

Atom-1	Atom-2	Clash(Å)	Distance(Å)	Models	
				Worst	Total
1:A:10:LEU:HD23	1:A:102:PHE:CD1	0.69	2.23	16	3
1:A:10:LEU:HD23	1:A:64:ILE:HG21	0.58	1.75	18	2
1:A:10:LEU:HD13	1:A:102:PHE:CE1	0.55	2.36	18	1
1:A:10:LEU:HB2	1:A:102:PHE:CZ	0.55	2.35	18	1
1:A:67:ASP:OD1	1:A:69:HIS:CD2	0.51	2.64	16	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	98/139 (71%)	93±2 (95±2%)	3±2 (4±2%)	2±1 (2±1%)	17	61
All	All	1960/2780 (71%)	1859 (95%)	69 (4%)	32 (2%)	17	61

5 of 7 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	34	SER	15
1	A	74	THR	8
1	A	98	GLU	4
1	A	36	GLY	2
1	A	37	LYS	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	85/121 (70%)	68±3 (80±4%)	17±3 (20±4%)	5 36
All	All	1700/2420 (70%)	1366 (80%)	334 (20%)	5 36

5 of 56 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	37	LYS	19
1	A	92	TYR	19
1	A	91	THR	18
1	A	10	LEU	17
1	A	102	PHE	16

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 carbohydrates 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 68% for the well-defined parts and 56% for the entire structure.

7.1 Chemical shift list 1

File name: 2lfp_cs.str

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	1092
Number of shifts mapped to atoms	1092
Number of unparsed shifts	0
Number of shifts with mapping errors	0
Number of shifts with mapping warnings	0
Number of shift outliers (ShiftChecker)	4

7.1.2 Chemical shift referencing (i)

The following table shows the suggested chemical shift referencing corrections.

Nucleus	# values	Correction ± precision, *ppm*	Suggested action
$^{13}C_{\alpha}$	110	-0.40 ± 0.26	None needed (< 0.5 ppm)
$^{13}C_{\beta}$	94	-0.32 ± 0.18	None needed (< 0.5 ppm)
$^{13}C'$	0	—	—
^{15}N	100	-0.01 ± 0.42	None needed (< 0.5 ppm)

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 68%, i.e. 825 atoms were assigned a chemical shift out of a possible 1205. 1 out of 16 assigned methyl groups (LEU and VAL) were assigned stereospecifically.

	Total	^{1}H	^{13}C	^{15}N
Backbone	362/480 (75%)	181/191 (95%)	94/196 (48%)	87/93 (94%)
Sidechain	389/622 (63%)	268/363 (74%)	121/234 (52%)	0/25 (0%)

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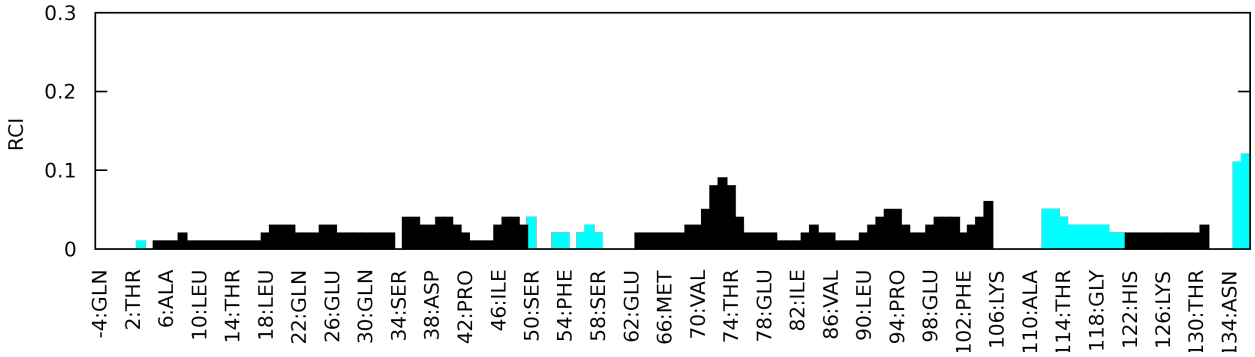
	Total	^{1}H	^{13}C	^{15}N
Aromatic	74/103 (72%)	48/55 (87%)	25/45 (56%)	1/3 (33%)
Overall	825/1205 (68%)	497/609 (82%)	240/475 (51%)	88/121 (73%)

7.1.4 Statistically unusual chemical shifts (i)

The following table lists the statistically unusual chemical shifts. These are statistical measures, and large deviations from the mean do not necessarily imply incorrect assignments. Molecules containing paramagnetic centres or hemes are expected to give rise to anomalous chemical shifts.

Mol	Chain	Res	Type	Atom	Shift, *ppm*	Expected range, *ppm*	Z-score
1	A	12	LYS	CD	42.70	34.86 – 23.06	11.6
1	A	10	LEU	HD11	-0.86	2.16 – -0.64	-5.8
1	A	10	LEU	HD12	-0.86	2.16 – -0.64	-5.8
1	A	10	LEU	HD13	-0.86	2.16 – -0.64	-5.8

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.

Random coil index (RCI) for chain A: