wwPDB NMR Structure Validation Summary Report (i)

Apr 27, 2016 – 03:20 AM BST

PDB ID	:	2MHK
Title	:	E. coli LpoA N-terminal domain
Authors	:	Jean, N.L.; Bougault, C.; Lodge, A.; Derouaux, A.; Callens, G.; Egan, A.; Lewis, R.J.; Vollmer, W.; Simorre, J.
Deposited on	:	2013-11-26

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:

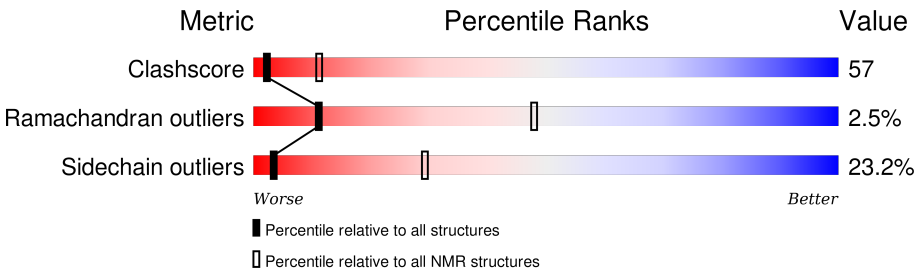
Cyrange	:	Kirchner and Güntert (2011)
NmrClust	:	Kelley et al. (1996)
MolProbity	:	4.02b-467
Mogul	:	unknown
Percentile statistics	:	20151230.v01 (using entries in the PDB archive December 30th 2015)
RCI	:	v_1n_11_5_13_A (Berjanski et al., 2005)
PANAV	:	Wang et al. (2010)
ShiftChecker	:	rb-20027457
Ideal 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 88%.

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	250	25% 47% 14% 14%

2 Ensemble composition and analysis (i)

This entry contains 20 models. Model 10 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:28-A:188, A:192-A:246 (216)	0.16	10

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 3 single-model clusters were found.

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

3 Entry composition (i)

There is only 1 type of molecule in this entry. The entry contains 3916 atoms, of which 1945 are hydrogens and 0 are deuteriums.

- Molecule 1 is a protein called Penicillin-binding protein activator LpoA.

Mol	Chain	Residues	Atoms						Trace
			Total	C	H	N	O	S	
1	A	250	3916	1224	1945	362	377	8	0

There are 21 discrepancies between the modelled and reference sequences:

Chain	Residue	Modelled	Actual	Comment	Reference
A	1	MET	-	EXPRESSION TAG	UNP P45464
A	2	GLY	-	EXPRESSION TAG	UNP P45464
A	3	SER	-	EXPRESSION TAG	UNP P45464
A	4	SER	-	EXPRESSION TAG	UNP P45464
A	5	HIS	-	EXPRESSION TAG	UNP P45464
A	6	HIS	-	EXPRESSION TAG	UNP P45464
A	7	HIS	-	EXPRESSION TAG	UNP P45464
A	8	HIS	-	EXPRESSION TAG	UNP P45464
A	9	HIS	-	EXPRESSION TAG	UNP P45464
A	10	HIS	-	EXPRESSION TAG	UNP P45464
A	11	SER	-	EXPRESSION TAG	UNP P45464
A	12	SER	-	EXPRESSION TAG	UNP P45464
A	13	GLY	-	EXPRESSION TAG	UNP P45464
A	14	LEU	-	EXPRESSION TAG	UNP P45464
A	15	VAL	-	EXPRESSION TAG	UNP P45464
A	16	PRO	-	EXPRESSION TAG	UNP P45464
A	17	ARG	-	EXPRESSION TAG	UNP P45464
A	18	GLY	-	EXPRESSION TAG	UNP P45464
A	19	SER	-	EXPRESSION TAG	UNP P45464
A	20	HIS	-	EXPRESSION TAG	UNP P45464
A	21	MET	-	EXPRESSION TAG	UNP P45464

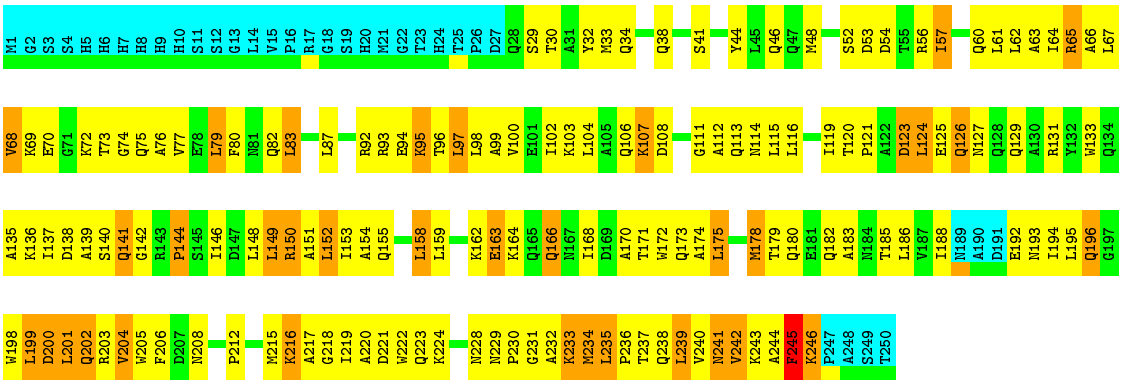
4 Residue-property plots (i)

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: Penicillin-binding protein activator LpoA

Chain A: 25% 47% 14% 14%

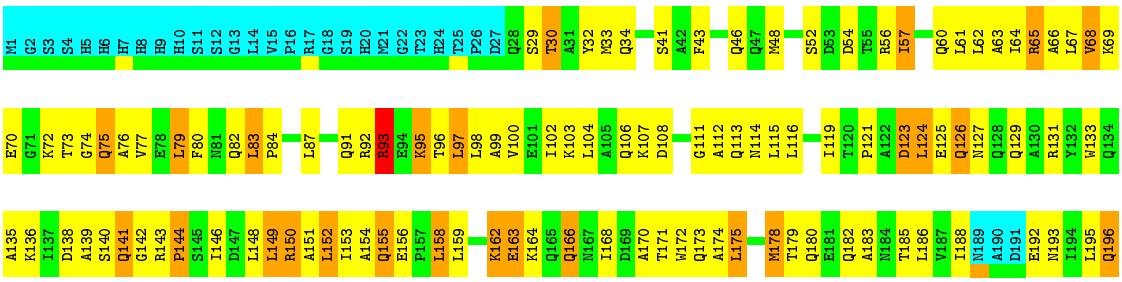


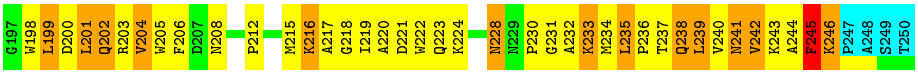
4.2 Residue scores for the representative (medoid) model from the NMR ensemble

The representative model is number 10. Colouring as in section 4.1 above.

- Molecule 1: Penicillin-binding protein activator LpoA

Chain A: 26% 44% 15% • 14%




G197
W198
L199
D200
L201
Q202
R203
V204
W205
F206
D207
N208
P212
N215
K216
A217
G218
I219
A220
D221
W222
Q223
K224
N228
N229
P230
G231
A232
K233
M234
L235
P236
T237
Q238
L239
V240
N241
V242
K243
A244
F245
K246
P247
A248
S249
T250

5 Refinement protocol and experimental data overview (i)

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

Of the 700 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	1.2
CNS	refinement	1.2

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)	2mhk_cs.str
Number of chemical shift lists	1
Total number of shifts	2919
Number of shifts mapped to atoms	2919
Number of unparsed shifts	0
Number of shifts with mapping errors	0
Number of shifts with mapping warnings	0
Assignment completeness (well-defined parts)	88%

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	0.60±0.03	1±1/1749 (0.1±0.1%)	0.76±0.01	0±0/2370 (0.0±0.0%)
All	All	0.60	29/34980 (0.1%)	0.76	1/47400 (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	Planarity
1	A	0.0±0.0	0.1±0.2
All	All	0	1

5 of 8 unique bond 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(Å)	Ideal(Å)	Models	
								Worst	Total
1	A	44	TYR	CE1-CZ	9.02	1.50	1.38	18	5
1	A	44	TYR	CE2-CZ	-8.81	1.27	1.38	18	5
1	A	80	PHE	CE2-CZ	8.23	1.52	1.37	6	4
1	A	245	PHE	CE2-CZ	7.26	1.51	1.37	16	4
1	A	206	PHE	CE1-CZ	6.64	1.50	1.37	9	5

All unique angle outliers are listed below.

Mol	Chain	Res	Type	Atoms	Z	Observed(^{o})	Ideal(^{o})	Models	
								Worst	Total
1	A	93	ARG	NE-CZ-NH1	6.28	123.44	120.30	10	1

There are no chirality outliers.

All unique planar outliers are listed below.

Mol	Chain	Res	Type	Group	Models (Total)
1	A	245	PHE	Sidechain	1

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	1720	1720	1720	196±7
All	All	34400	34400	34400	3930

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 57.

5 of 415 unique clashes are listed below, sorted by their clash magnitude.

Atom-1	Atom-2	Clash(Å)	Distance(Å)	Models	
				Worst	Total
1:A:61:LEU:HA	1:A:98:LEU:HD21	0.98	1.29	16	20
1:A:32:TYR:HB2	1:A:62:LEU:HD21	0.96	1.36	8	20
1:A:172:TRP:CD1	1:A:238:GLN:HB2	0.90	2.02	11	20
1:A:231:GLY:O	1:A:235:LEU:HG	0.84	1.71	13	20
1:A:164:LYS:O	1:A:168:ILE:HG12	0.82	1.74	13	20

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	216/250 (86%)	189±2 (88±1%)	22±2 (10±1%)	5±1 (2±0%)	11	48
All	All	4320/5000 (86%)	3781 (88%)	432 (10%)	107 (2%)	11	48

5 of 9 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	246	LYS	20
1	A	124	LEU	20
1	A	141	GLN	20
1	A	144	PRO	19
1	A	53	ASP	16

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	180/208 (87%)	138±3 (77±2%)	42±3 (23±2%)	3 29
All	All	3600/4160 (87%)	2763 (77%)	837 (23%)	3 29

5 of 85 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	68	VAL	20
1	A	216	LYS	20
1	A	57	ILE	20
1	A	149	LEU	20
1	A	204	VAL	20

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 88% for the well-defined parts and 84% for the entire structure.

7.1 Chemical shift list 1

File name: 2mhk_cs.str

Chemical shift list name: *assigned_chem_shift_list*

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	2919
Number of shifts mapped to atoms	2919
Number of unparsed shifts	0
Number of shifts with mapping errors	0
Number of shifts with mapping warnings	0
Number of shift outliers (ShiftChecker)	15

7.1.2 Chemical shift referencing (i)

The following table shows the suggested chemical shift referencing corrections.

Nucleus	# values	Correction ± precision, *ppm*	Suggested action
$^{13}C_{\alpha}$	239	-1.31 ± 0.05	Should be applied
$^{13}C_{\beta}$	225	-0.83 ± 0.08	Should be applied
$^{13}C'$	226	-0.20 ± 0.05	None needed (< 0.5 ppm)
^{15}N	224	0.35 ± 0.27	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 88%, i.e. 2414 atoms were assigned a chemical shift out of a possible 2731. 0 out of 32 assigned methyl groups (LEU and VAL) were assigned stereospecifically.

	Total	^{1}H	^{13}C	^{15}N
Backbone	1049/1064 (99%)	422/424 (100%)	421/432 (97%)	206/208 (99%)
Sidechain	1237/1518 (81%)	739/888 (83%)	465/544 (85%)	33/86 (38%)

Continued on next page...

Continued from previous page...

	Total	^{1}H	^{13}C	^{15}N
Aromatic	128/149 (86%)	66/77 (86%)	56/66 (85%)	6/6 (100%)
Overall	2414/2731 (88%)	1227/1389 (88%)	942/1042 (90%)	245/300 (82%)

7.1.4 Statistically unusual chemical shifts (i)

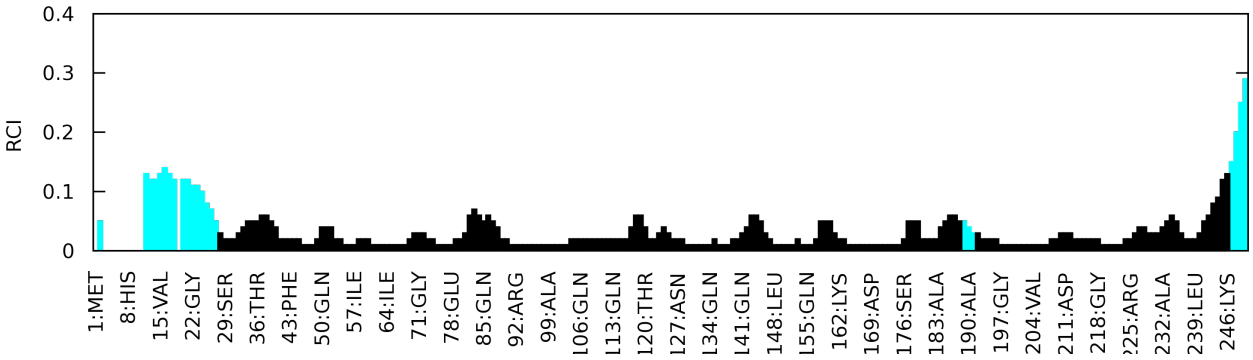
The following table lists the statistically unusual chemical shifts. These are statistical measures, and large deviations from the mean do not necessarily imply incorrect assignments. Molecules containing paramagnetic centres or hemes are expected to give rise to anomalous chemical shifts.

Mol	Chain	Res	Type	Atom	Shift, *ppm*	Expected range, *ppm*	Z-score
1	A	47	GLN	HG2	-0.11	3.67 – 0.97	-9.0
1	A	47	GLN	HB3	-0.38	3.37 – 0.67	-8.9
1	A	176	SER	HB2	1.80	5.18 – 2.58	-8.0
1	A	47	GLN	HB2	0.26	3.30 – 0.80	-7.2
1	A	201	LEU	HB2	-0.74	3.32 – -0.08	-6.9
1	A	171	THR	HG22	-0.33	2.29 – -0.01	-6.4
1	A	171	THR	HG21	-0.33	2.29 – -0.01	-6.4
1	A	171	THR	HG23	-0.33	2.29 – -0.01	-6.4
1	A	209	ARG	HD2	1.67	4.27 – 1.97	-6.3
1	A	172	TRP	HZ2	5.57	8.89 – 5.69	-5.4
1	A	154	ALA	HB1	0.03	2.61 – 0.11	-5.3
1	A	154	ALA	HB2	0.03	2.61 – 0.11	-5.3
1	A	154	ALA	HB3	0.03	2.61 – 0.11	-5.3
1	A	47	GLN	HG3	0.80	3.75 – 0.85	-5.2
1	A	29	SER	HB2	2.57	5.18 – 2.58	-5.0

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:


RCI
0.4
0.3
0.2
0.1
0
1:MET
8:HIS
15:VAL
22:GLY
29:SER
36:THR
43:PHE
50:GLN
57:ILE
64:ILE
71:GLY
78:GLU
85:GLN
92:ARG
99:ALA
106:GLN
113:GLN
120:THR
127:ASN
134:GLN
141:GLN
148:LEU
155:GLN
162:LYS
169:ASP
176:SER
183:ALA
190:ALA
197:GLY
204:VAL
211:ASP
218:GLY
225:ARG
232:ALA
239:LEU
246:LYS