Full wwPDB NMR Structure Validation Report (i)

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PDB ID	:	2MNG
Title	:	Apo Structure of human HCN4 CNBD solved by NMR
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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
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:

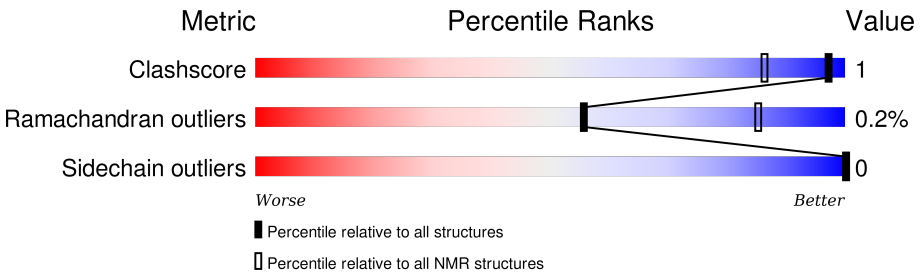
Cyrange	:	Kirchner and Güntert (2011)
NmrClust	:	Kelley et al. (1996)
MolProbity	:	4.02b-467
Mogul	:	unknown
Percentile statistics	:	20151230.v01 (using entries in the PDB archive December 30th 2015)
RCI	:	v_1n_11_5_13_A (Berjanski et al., 2005)
PANAV	:	Wang et al. (2010)
ShiftChecker	:	rb-20027457
Ideal 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	131	87% • 12%

2 Ensemble composition and analysis (i)

This entry contains 10 models. Model 4 is the overall representative, medoid model (most similar to other models). The authors have identified model 1 as representative, based on the following criterion: *closest to the average*.

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:586-A:700 (115)	0.82	4

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 2 single-model clusters were found.

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

3 Entry composition (i)

There is only 1 type of molecule in this entry. The entry contains 2102 atoms, of which 1052 are hydrogens and 0 are deuteriums.

- Molecule 1 is a protein called Potassium/sodium hyperpolarization-activated cyclic nucleotide-gated channel 4.

Mol	Chain	Residues	Atoms						Trace
			Total	C	H	N	O	S	
1	A	131	2102	667	1052	180	195	8	0

There are 2 discrepancies between the modelled and reference sequences:

Chain	Residue	Modelled	Actual	Comment	Reference
A	577	ASN	-	EXPRESSION TAG	UNP Q9Y3Q4
A	578	SER	-	EXPRESSION TAG	UNP Q9Y3Q4

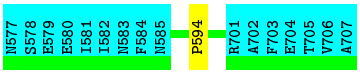
4 Residue-property plots (i)

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: Potassium/sodium hyperpolarization-activated cyclic nucleotide-gated channel 4

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: Potassium/sodium hyperpolarization-activated cyclic nucleotide-gated channel 4

Chain A:

4.2.2 Score per residue for model 2

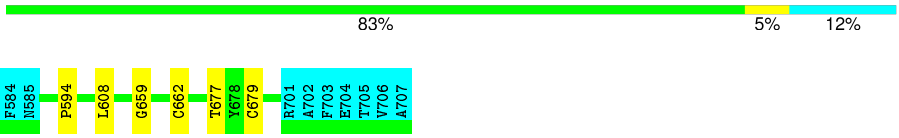
• Molecule 1: Potassium/sodium hyperpolarization-activated cyclic nucleotide-gated channel 4

Chain A:

4.2.3 Score per residue for model 3

• Molecule 1: Potassium/sodium hyperpolarization-activated cyclic nucleotide-gated channel 4

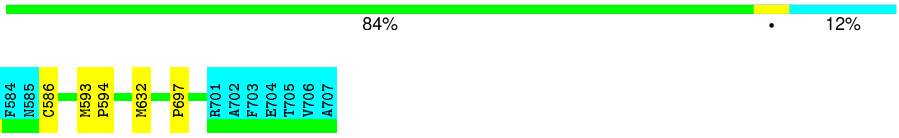
Chain A:



4.2.4 Score per residue for model 4 (medoid)

• Molecule 1: Potassium/sodium hyperpolarization-activated cyclic nucleotide-gated channel 4

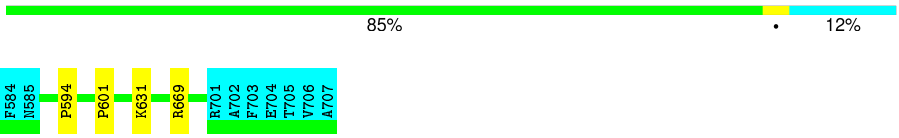
Chain A:



4.2.5 Score per residue for model 5

• Molecule 1: Potassium/sodium hyperpolarization-activated cyclic nucleotide-gated channel 4

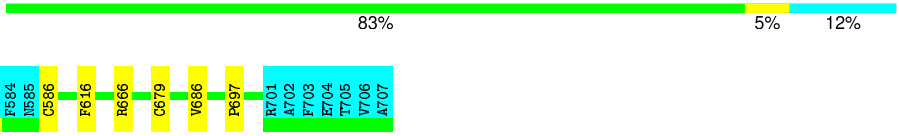
Chain A:



4.2.6 Score per residue for model 6

• Molecule 1: Potassium/sodium hyperpolarization-activated cyclic nucleotide-gated channel 4

Chain A:



4.2.7 Score per residue for model 7

• Molecule 1: Potassium/sodium hyperpolarization-activated cyclic nucleotide-gated channel 4

Chain A: 87% • 12%

N577 S578 E579 E580 I581 I582 N583 F584 N585 L663 R701 A702 F703 E704 T705 V706 A707

4.2.8 Score per residue for model 8

• Molecule 1: Potassium/sodium hyperpolarization-activated cyclic nucleotide-gated channel 4

Chain A: 84% • 12%

N577 S578 E579 E580 I581 I582 N583 F584 N585 P594 P601 K630 G659 C662 R701 A702 F703 E704 T705 V706 A707

4.2.9 Score per residue for model 9

• Molecule 1: Potassium/sodium hyperpolarization-activated cyclic nucleotide-gated channel 4

Chain A: 82% 5% 12%

N577 S578 E579 E580 I581 I582 N583 F584 N585 P594 P601 F616 K631 R669 C679 P697 R701 A702 F703 E704 T705 V706 A707

4.2.10 Score per residue for model 10

• Molecule 1: Potassium/sodium hyperpolarization-activated cyclic nucleotide-gated channel 4

Chain A: 85% • 12%

N577 S578 E579 E580 I581 I582 N583 F584 N585 P594 G659 C662 P697 R701 A702 F703 E704 T705 V706 A707

5 Refinement protocol and experimental data overview (i)

The models were refined using the following method: *?*.

Of the 50000 calculated structures, 10 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
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)	2mng_cs.str
Number of chemical shift lists	1
Total number of shifts	1243
Number of shifts mapped to atoms	1243
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	0.71±0.01	2±1/937 (0.2±0.1%)	0.59±0.00	0±0/1262 (0.0±0.0%)
All	All	0.71	17/9370 (0.2%)	0.59	0/12620 (0.0%)

All 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	594	PRO	N-CD	6.25	1.56	1.47	5	8
1	A	697	PRO	N-CD	6.20	1.56	1.47	4	4
1	A	601	PRO	N-CD	6.13	1.56	1.47	5	4
1	A	618	PRO	N-CD	5.13	1.55	1.47	1	1

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	919	930	930	2±1
All	All	9190	9300	9300	16

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:608:LEU:O	1:A:608:LEU:HD23	0.71	1.86	3	1
1:A:616:PHE:HB2	1:A:679:CYS:SG	0.59	2.37	6	3
1:A:663:LEU:C	1:A:663:LEU:HD23	0.48	2.28	7	1
1:A:659:GLY:O	1:A:662:CYS:HB2	0.48	2.09	3	2
1:A:631:LYS:O	1:A:669:ARG:NH2	0.48	2.42	9	1
1:A:659:GLY:HA2	1:A:662:CYS:SG	0.47	2.49	8	1
1:A:677:THR:O	1:A:679:CYS:SG	0.47	2.61	3	1
1:A:608:LEU:C	1:A:608:LEU:HD23	0.46	2.31	3	1
1:A:666:ARG:HD3	1:A:686:VAL:HB	0.45	1.89	6	1
1:A:593:MET:SD	1:A:632:MET:SD	0.43	3.16	4	1
1:A:631:LYS:H	1:A:669:ARG:NH2	0.43	2.12	5	1
1:A:659:GLY:O	1:A:662:CYS:HB3	0.40	2.16	2	1
1:A:608:LEU:C	1:A:608:LEU:CD2	0.40	2.89	3	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	115/131 (88%)	112±1 (97±1%)	3±1 (3±1%)	0±0 (0±0%)	56	85
All	All	1150/1310 (88%)	1116 (97%)	32 (3%)	2 (0%)	56	85

All 1 unique Ramachandran outliers are listed below.

Mol	Chain	Res	Type	Models (Total)
1	A	630	LYS	2

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	101/115 (88%)	101±0 (100±0%)	0±0 (0±0%)	100	100
All	All	1010/1150 (88%)	1010 (100%)	0 (0%)	100	100

There are no protein residues with a non-rotameric sidechain to report.

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 69% for the entire structure.

7.1 Chemical shift list 1

File name: 2mng_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	1243
Number of shifts mapped to atoms	1243
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
$^{13}C_{\alpha}$	118	-0.16 ± 0.09	None needed (< 0.5 ppm)
$^{13}C_{\beta}$	112	0.07 ± 0.09	None needed (< 0.5 ppm)
$^{13}C'$	115	0.10 ± 0.09	None needed (< 0.5 ppm)
^{15}N	118	0.55 ± 0.48	None needed (imprecise)

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. 992 atoms were assigned a chemical shift out of a possible 1452. 16 out of 20 assigned methyl groups (LEU and VAL) were assigned stereospecifically.

	Total	^{1}H	^{13}C	^{15}N
Backbone	510/567 (90%)	204/226 (90%)	203/230 (88%)	103/111 (93%)
Sidechain	482/767 (63%)	289/451 (64%)	193/275 (70%)	0/41 (0%)

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	Total	^{1}H	^{13}C	^{15}N
Aromatic	0/118 (0%)	0/63 (0%)	0/54 (0%)	0/1 (0%)
Overall	992/1452 (68%)	493/740 (67%)	396/559 (71%)	103/153 (67%)

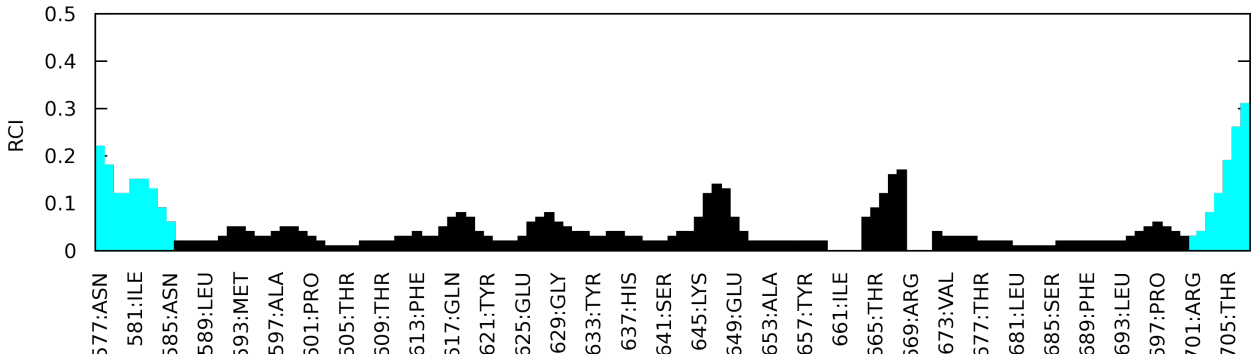
The following table shows the completeness of the chemical shift assignments for the full structure. The overall completeness is 69%, i.e. 1139 atoms were assigned a chemical shift out of a possible 1651. 17 out of 21 assigned methyl groups (LEU and VAL) were assigned stereospecifically.

	Total	^{1}H	^{13}C	^{15}N
Backbone	585/647 (90%)	234/258 (91%)	233/262 (89%)	118/127 (93%)
Sidechain	554/868 (64%)	334/509 (66%)	220/312 (71%)	0/47 (0%)
Aromatic	0/136 (0%)	0/73 (0%)	0/62 (0%)	0/1 (0%)
Overall	1139/1651 (69%)	568/840 (68%)	453/636 (71%)	118/175 (67%)

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.

Random coil index (RCI) for chain A: