wwPDB NMR Structure Validation Summary Report

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PDB ID	:	4AR0
Title	:	N0 domain of Neisseria meningitidis Pilus assembly protein PilQ
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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
https://www.wwpdb.org/validation/2017/NMRValidationReportHelp
with specific help available everywhere you see the (i) symbol.

The following versions of software and data (see references (1)) were used in the production of this report:

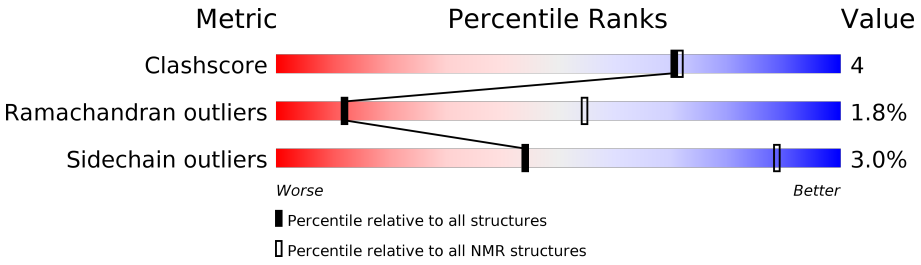
Cyrange	:	Kirchner and Güntert (2011)
NmrClust	:	Kelley et al. (1996)
MolProbity	:	4.02b-467
Percentile statistics	:	20191225.v01 (using entries in the PDB archive December 25th 2019)
RCI	:	v_1n_11_5_13_A (Berjanski et al., 2005)
PANAV	:	Wang et al. (2010)
ShiftChecker	:	2.11
Ideal geometry (proteins)	:	Engh & Huber (2001)
Ideal geometry (DNA, RNA)	:	Parkinson et al. (1996)
Validation Pipeline (wwPDB-VP)	:	2.11

1 Overall quality at a glance

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

The overall completeness of chemical shifts assignment is 92%.

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	128	59% · 40%

2 Ensemble composition and analysis

This entry contains 20 models. Model 1 is the overall representative, medoid model (most similar to other models).

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:345-A:421 (77)	0.49	1

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 4 clusters and 5 single-model clusters were found.

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

3 Entry composition

There is only 1 type of molecule in this entry. The entry contains 2026 atoms, of which 1011 are hydrogens and 0 are deuteriums.

- Molecule 1 is a protein called TYPE IV PILUS BIOGENESIS AND COMPETENCE PROTEIN PILQ.

Mol	Chain	Residues	Atoms						Trace
			Total	C	H	N	O	S	
1	A	128	2026	637	1011	177	194	7	0

There are 29 discrepancies between the modelled and reference sequences:

Chain	Residue	Modelled	Actual	Comment	Reference
A	315	MET	-	expression tag	UNP Q70M91
A	316	LYS	-	expression tag	UNP Q70M91
A	317	HIS	-	expression tag	UNP Q70M91
A	318	HIS	-	expression tag	UNP Q70M91
A	319	HIS	-	expression tag	UNP Q70M91
A	320	HIS	-	expression tag	UNP Q70M91
A	321	HIS	-	expression tag	UNP Q70M91
A	322	HIS	-	expression tag	UNP Q70M91
A	323	PRO	-	expression tag	UNP Q70M91
A	324	MET	-	expression tag	UNP Q70M91
A	325	SER	-	expression tag	UNP Q70M91
A	326	ASP	-	expression tag	UNP Q70M91
A	327	TYR	-	expression tag	UNP Q70M91
A	328	ASP	-	expression tag	UNP Q70M91
A	329	ILE	-	expression tag	UNP Q70M91
A	330	PRO	-	expression tag	UNP Q70M91
A	331	THR	-	expression tag	UNP Q70M91
A	332	THR	-	expression tag	UNP Q70M91
A	333	GLU	-	expression tag	UNP Q70M91
A	334	ASN	-	expression tag	UNP Q70M91
A	335	LEU	-	expression tag	UNP Q70M91
A	336	TYR	-	expression tag	UNP Q70M91
A	337	PHE	-	expression tag	UNP Q70M91
A	338	GLU	-	expression tag	UNP Q70M91
A	339	GLY	-	expression tag	UNP Q70M91
A	340	ALA	-	expression tag	UNP Q70M91
A	341	MET	-	expression tag	UNP Q70M91
A	342	GLY	-	expression tag	UNP Q70M91
A	428	PHE	LEU	variant	UNP Q70M91

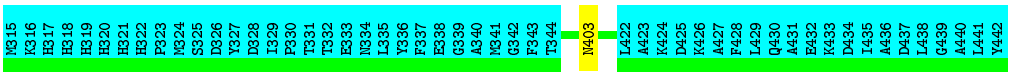
4 Residue-property plots (i)

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: TYPE IV PILUS BIOGENESIS AND COMPETENCE PROTEIN PILQ

Chain A:

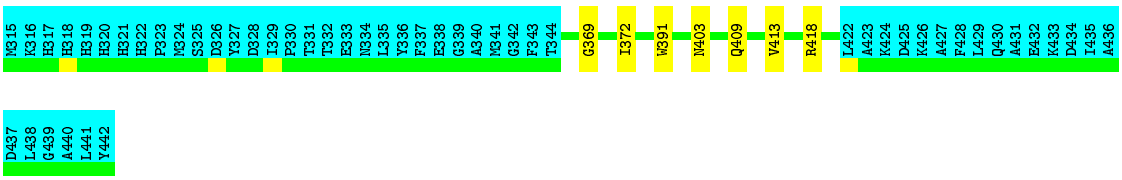


4.2 Residue scores for the representative (medoid) model from the NMR ensemble

The representative model is number 1. Colouring as in section 4.1 above.

- Molecule 1: TYPE IV PILUS BIOGENESIS AND COMPETENCE PROTEIN PILQ

Chain A:



5 Refinement protocol and experimental data overview

The models were refined using the following method: *CYANA2.1 AND CNS1.2 WATER REFINEMENT*.

Of the 100 calculated structures, 20 were deposited, based on the following criterion: *LOWEST ENERGY*.

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

Software name	Classification	Version
CYANA2.1	refinement	
TOPSPIN2.1	structure solution	
CCPN ANALYSIS	structure solution	ANALYSIS
CYANA2.1	structure solution	
CNS1.2	structure solution	
TALOSPLUS	structure solution	

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)	input_cs.cif
Number of chemical shift lists	1
Total number of shifts	1520
Number of shifts mapped to atoms	1507
Number of unparsed shifts	0
Number of shifts with mapping errors	0
Number of shifts with mapping warnings	13
Assignment completeness (well-defined parts)	92%

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

6 Model quality

6.1 Standard geometry

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

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	0.2±0.4
All	All	0	4

There are no bond-length outliers.

There are no bond-angle outliers.

There are no chirality outliers.

All 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	402	ARG	Sidechain	2
1	A	407	ARG	Sidechain	1
1	A	358	ARG	Sidechain	1

6.2 Too-close contacts

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	602	620	620	4±3
All	All	12040	12400	12400	89

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 4.

5 of 54 unique clashes are listed below, sorted by their clash magnitude.

Atom-1	Atom-2	Clash(Å)	Distance(Å)	Models	
				Worst	Total
1:A:382:MET:SD	1:A:384:LEU:HG	0.65	2.31	17	2
1:A:395:LEU:HG	1:A:399:MET:SD	0.60	2.36	10	1
1:A:395:LEU:O	1:A:398:VAL:HG22	0.58	1.99	2	2
1:A:362:GLN:HE21	1:A:362:GLN:HA	0.57	1.60	8	1
1:A:375:SER:O	1:A:378:VAL:HG12	0.55	2.01	7	3

6.3 Torsion angles

6.3.1 Protein backbone

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	77/128 (60%)	71±1 (92±2%)	5±2 (6±2%)	1±0 (2±1%)	12	54
All	All	1540/2560 (60%)	1413 (92%)	100 (6%)	27 (2%)	12	54

5 of 8 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	403	ASN	19
1	A	368	SER	2
1	A	379	ASN	1
1	A	388	ASP	1
1	A	353	GLN	1

6.3.2 Protein sidechains

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	68/110 (62%)	66±1 (97±2%)	2±1 (3±2%)	44	89
All	All	1360/2200 (62%)	1319 (97%)	41 (3%)	44	89

5 of 20 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	387	LYS	5
1	A	384	LEU	5
1	A	409	GLN	5
1	A	364	LEU	4
1	A	346	ARG	2

6.3.3 RNA

There are no RNA molecules in this entry.

6.4 Non-standard residues in protein, DNA, RNA chains

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

6.5 Carbohydrates

There are no carbohydrates in this entry.

6.6 Ligand geometry

There are no ligands in this entry.

6.7 Other polymers

There are no such molecules in this entry.

6.8 Polymer linkage issues

There are no chain breaks in this entry.

7 Chemical shift validation

The completeness of assignment taking into account all chemical shift lists is 92% for the well-defined parts and 84% for the entire structure.

7.1 Chemical shift list 1

File name: input_cs.cif

Chemical shift list name: *assigned_chem_shift_list*

7.1.1 Bookkeeping

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	1520
Number of shifts mapped to atoms	1507
Number of unparsed shifts	0
Number of shifts with mapping errors	0
Number of shifts with mapping warnings	13
Number of shift outliers (ShiftChecker)	0

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

- No matching atoms found in structure. First 5 (of 13) occurences are reported below.

Chain	Res	Type	Atom	Shift Data		
				Value	Uncertainty	Ambiguity
A	427	ALA	3HB	1.277	0.002	2
A	401	ALA	3HB	1.474	0.008	2
A	436	ALA	3HB	1.301	0.0	2
A	431	ALA	3HB	1.324	0.001	2
A	440	ALA	3HB	1.244	0.0	2

7.1.2 Chemical shift referencing

The following table shows the suggested chemical shift referencing corrections.

Nucleus	# values	Correction ± precision, *ppm*	Suggested action
$^{13}C_{\alpha}$	120	-0.16 ± 0.09	None needed (< 0.5 ppm)
$^{13}C_{\beta}$	113	0.24 ± 0.11	None needed (< 0.5 ppm)
$^{13}C'$	106	0.28 ± 0.16	None needed (< 0.5 ppm)

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Nucleus	# values	Correction ± precision, *ppm*	Suggested action
^{15}N	116	-0.44 ± 0.34	None needed (< 0.5 ppm)

7.1.3 Completeness of resonance assignments

The following table shows the completeness of the chemical shift assignments for the well-defined regions of the structure. The overall completeness is 92%, i.e. 880 atoms were assigned a chemical shift out of a possible 961. 0 out of 15 assigned methyl groups (LEU and VAL) were assigned stereospecifically.

	Total	^{1}H	^{13}C	^{15}N
Backbone	375/381 (98%)	152/152 (100%)	148/154 (96%)	75/75 (100%)
Sidechain	486/559 (87%)	297/324 (92%)	175/205 (85%)	14/30 (47%)
Aromatic	19/21 (90%)	9/11 (82%)	9/9 (100%)	1/1 (100%)
Overall	880/961 (92%)	458/487 (94%)	332/368 (90%)	90/106 (85%)

7.1.4 Statistically unusual chemical shifts

There are no statistically unusual chemical shifts.

7.1.5 Random Coil Index (RCI) plots

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: