Integrative Structure Validation Report

October 16, 2025 - 05:32 PM PDT

The following software was used in the production of this report:

IHMValidation Version 3.0
Python-IHM Version 2.5
MolProbity Version 4.5.2
PrISM Version dbe5a41
PyMOL Version 2.5.0

PDB ID	9A9G | pdb_00009a9g
Structure Title	Biologically relevant conformational ensembles of the extracellular region of Streptococcus pneumoniae PsrSp
Structure Authors	Lesovoy, D.; Sala, B.M.; Sandalova, T.; Achour, A.; Orekhov, V.; Roshchin, K.; Agback, T.; Agback, P.
Deposited on	2025-01-24

This is a PDB-IHM Structure Validation Report.

We welcome your comments at helpdesk@pdb-ihm.org

A user guide is available at https://pdb-ihm.org/validation_help.html with specific help available everywhere you see the ? symbol.

List of references used to build this report is available here.

1. Overview

1.1. Summary

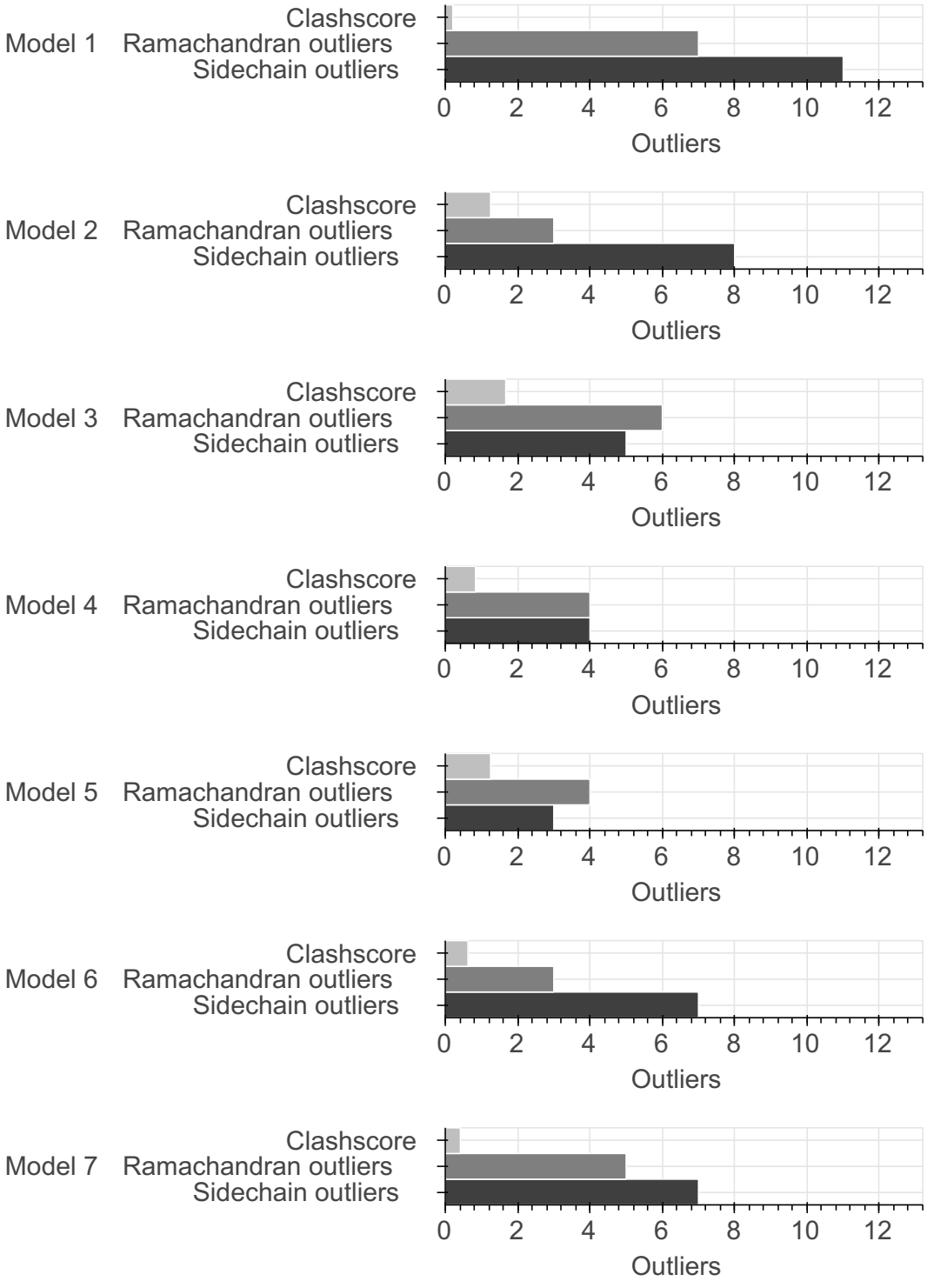
This entry consists of 20 model(s). A total of 2 dataset(s) were used to build this entry.

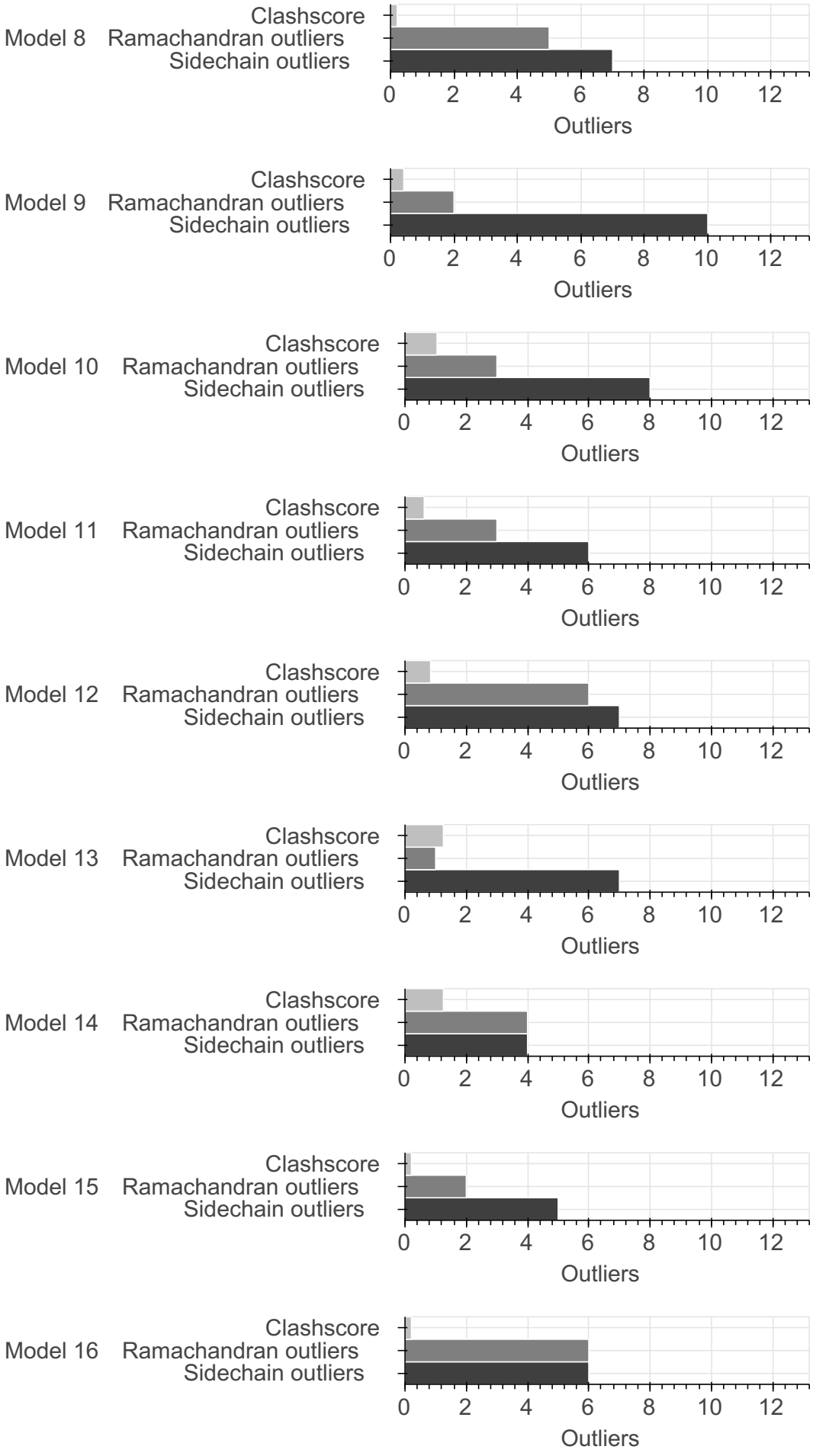
Name	Type	Count
NMR data	Experimental data	1
De Novo model	Starting model	1

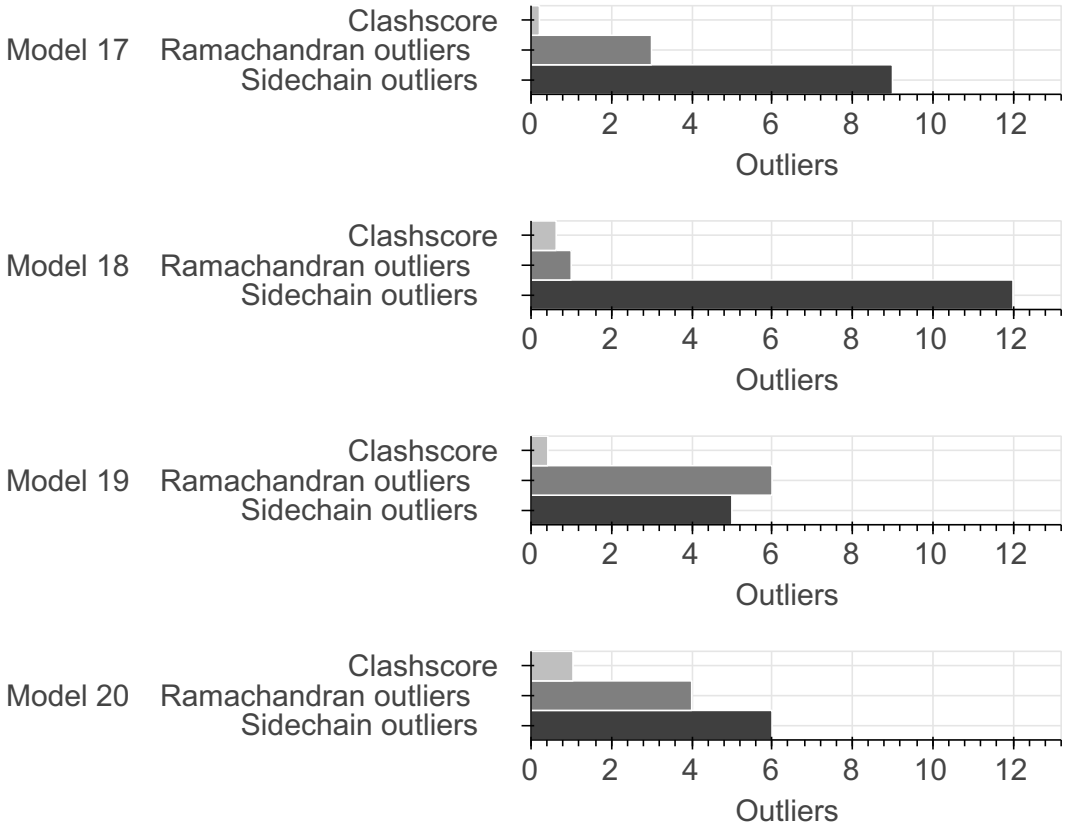
1.2. Overall quality

This validation report contains model quality assessments for all structures, data quality and fit to model assessments for SAS and crosslinking-MS datasets. Data quality and fit to model assessments for other datasets and model uncertainty are under development. Number of plots is limited to 256.

Model Quality: MolProbity Analysis




Model 8
Model 9
Model 10
Model 11
Model 12
Model 13
Model 14
Model 15
Model 16
Clashscore
Ramachandran outliers
Sidechain outliers
0
2
4
6
8
10
12
Outliers



2. Model Details

2.1. Ensemble information

This entry consists of 1 distinct ensemble(s).

2.2. Representation

This entry has 1 representation(s).

ID	Model(s)	Entity ID	Molecule name	Chain(s) [auth]	Total residues	Rigid segments	Flexible segments	Model coverage/ Starting model coverage (%)	Scale
1	1-20	1	LCP Protein PsrSp	A	308	-	1-308	100.00 / 100.00	Atomic

2.3. Datasets used for modeling

There are 2 unique datasets used to build the models in this entry.

ID	Dataset type	Database name	Data access code
1	De Novo model	Not available	Not available
2	NMR data	BMRB	52556

2.4. Methodology and software

This entry is a result of 1 distinct protocol(s).

Step number	Protocol ID	Method name	Method type	Method description	Number of computed models	Multi state modeling	Multi scale modeling
1	1	Not available	Not available	The starting structure was obtained by AlphaFold3. Full-atom molecular dynamics, Charm36 force field with cufix correction were performed. After minimization and NVT, free dynamics in the NPT ensemble was launched for 3 microseconds. Based on the results of the RMS analysis, a stable region at 500 ns was selected for further analysis. Cluster analysis was performed and 20 most representative structures were identified.	Not available	False	False
2	1	Not available	Not available	Relaxation parameters for the MD trajectory are calculated.	Not available	False	False
3	1	Not available	Not available	Relaxation parameters for the MD trajectory are calculated.	Not available	False	False
4	1	Not available	Not available	NMR data processed	Not available	False	False
5	1	Not available	Not available	NMR data analysis	Not available	False	False
6	1	Not available	Not available	NMR data analysis	Not available	False	False

There are 7 software packages reported in this entry.

ID	Software name	Software version	Software classification	Software location
1	Gromacs	2022.40	model building	https://www.gromacs.org/
2	wolfram mathematica	Not available	data processing and validation	https://www.wolfram.com/mathematica/
3	Python	Not available	data processing	https://www.python.org/
4	TopSpin	4.06	data processing	https://www.bruker.com/en/products-and-solutions/mr/nmr-software/topspin.html
5	CcpNmr	2.4.2.62	other	https://ccpn.ac.uk/
6	Dynamics Center	2.80	other	https://www.bruker.com/en/products-and-solutions/mr/nmr-software/dynamics-center.html
7	AlphaFold	3	model building	https://alphafold.ebi.ac.uk/

3. Data quality

3.4. NMR

Validation for this section is under development.

4. Model quality

For models with atomic structures, MolProbity analysis is performed. For models with coarse-grained or multi-scale structures, excluded volume analysis is performed.

4.1b. MolProbity Analysis

Excluded volume satisfaction for the models in the entry are listed below. The Analysed column shows the number of particle-partice or particle-atom pairs for which excluded volume was analysed.

Standard geometry: bond outliers

There are 1529 bond length outliers in this entry (3.11% of 49100 assessed bonds). A summary is provided below. The output is limited to 100 rows.

Chain	Res	Type	Atoms	|Z|	Observed (Å)	Ideal (Å)	Model ID (Worst)	Models (Total)
A	2	HIS	CE1-NE2	9.55	1.42	1.32	12	9
A	6	HIS	CG-ND1	9.13	1.28	1.38	17	1
A	200	ARG	CD-NE	9.12	1.59	1.46	11	5
A	209	ARG	NE-CZ	9.02	1.23	1.33	2	3
A	5	HIS	CE1-NE2	8.97	1.41	1.32	3	5
A	6	HIS	CD2-NE2	8.62	1.28	1.37	6	1
A	5	HIS	CD2-NE2	8.53	1.47	1.37	16	3
A	4	HIS	CE1-NE2	8.37	1.40	1.32	5	8
A	188	MET	CA-CB	8.36	1.70	1.53	4	1
A	228	THR	C-N	8.20	1.44	1.33	6	6
A	275	GLU	C-N	8.06	1.44	1.33	14	2
A	209	ARG	CZ-NH2	7.94	1.23	1.33	15	3
A	164	THR	C-N	7.81	1.44	1.33	1	2
A	261	LEU	C-N	7.78	1.44	1.33	15	3
A	132	GLN	C-N	7.77	1.44	1.33	16	4
A	38	ARG	CZ-NH2	7.75	1.23	1.33	16	2
A	289	LEU	C-N	7.72	1.44	1.33	14	3
A	42	ASN	C-N	7.60	1.44	1.33	2	7
A	28	VAL	C-N	7.59	1.44	1.33	19	2
A	304	GLN	C-N	7.59	1.44	1.33	2	2
A	183	VAL	C-N	7.56	1.43	1.33	11	3
A	239	LYS	C-N	7.54	1.43	1.33	9	1
A	144	ASP	C-N	7.52	1.43	1.33	3	4

Chain	Res	Type	Atoms	|Z|	Observed (Å)	Ideal (Å)	Model ID (Worst)	Models (Total)
A	6	HIS	CE1-NE2	7.51	1.40	1.32	13	6
A	25	ARG	CD-NE	7.45	1.56	1.46	4	4
A	6	HIS	C-N	7.42	1.43	1.33	5	1
A	167	ASP	C-N	7.36	1.43	1.33	7	1
A	211	LYS	C-N	7.34	1.43	1.33	10	4
A	9	ASN	CA-CB	7.33	1.68	1.53	19	3
A	131	PHE	C-N	7.31	1.43	1.33	12	4
A	300	THR	C-N	7.28	1.43	1.33	17	4
A	227	PRO	C-N	7.26	1.43	1.33	19	3
A	287	GLY	N-CA	7.24	1.57	1.45	16	2
A	160	LEU	C-N	7.24	1.43	1.33	8	3
A	3	HIS	CE1-NE2	7.23	1.39	1.32	8	11
A	229	LYS	C-N	7.18	1.43	1.33	12	6
A	68	PHE	C-N	7.17	1.43	1.33	3	3
A	93	LEU	C-N	7.17	1.43	1.33	19	2
A	189	ASN	C-N	7.13	1.43	1.33	1	1
A	122	ASP	C-N	7.11	1.43	1.33	8	2
A	258	LEU	C-N	7.11	1.43	1.33	14	2
A	170	TYR	CA-C	7.10	1.67	1.52	9	1
A	252	PHE	C-N	7.06	1.43	1.33	20	4
A	234	SER	C-N	7.06	1.43	1.33	9	2
A	47	ARG	CD-NE	7.02	1.56	1.46	11	6
A	116	LYS	C-N	7.02	1.43	1.33	14	3
A	70	ARG	CD-NE	7.02	1.56	1.46	5	5
A	143	PRO	CA-CB	7.01	1.67	1.53	16	1
A	246	THR	C-N	6.98	1.43	1.33	9	2
A	213	GLN	C-N	6.98	1.43	1.33	2	3
A	198	ARG	CZ-NH2	6.95	1.24	1.33	4	5
A	74	VAL	C-N	6.93	1.43	1.33	14	3
A	269	GLU	C-N	6.89	1.43	1.33	19	2
A	298	TYR	CA-CB	6.87	1.67	1.53	9	1
A	12	PHE	C-N	6.86	1.42	1.33	4	2
A	49	ASP	N-CA	6.84	1.33	1.46	14	2
A	303	ALA	C-N	6.84	1.42	1.33	16	4
A	24	THR	C-N	6.84	1.42	1.33	19	4

Chain	Res	Type	Atoms	|Z|	Observed (Å)	Ideal (Å)	Model ID (Worst)	Models (Total)
A	238	GLY	C-N	6.83	1.42	1.33	14	3
A	1	MET	C-N	6.82	1.42	1.33	18	2
A	36	ASP	C-N	6.82	1.42	1.33	3	3
A	65	LEU	C-N	6.80	1.42	1.33	14	1
A	86	ARG	CD-NE	6.80	1.55	1.46	8	7
A	27	GLY	C-N	6.80	1.42	1.33	19	2
A	212	ARG	CD-NE	6.79	1.55	1.46	13	2
A	199	PHE	CA-CB	6.79	1.67	1.53	8	1
A	105	GLN	C-N	6.78	1.42	1.33	13	2
A	61	LYS	C-N	6.78	1.42	1.33	16	4
A	223	GLN	C-N	6.78	1.42	1.33	7	4
A	254	LEU	C-N	6.76	1.42	1.33	15	2
A	279	TRP	C-N	6.68	1.42	1.33	20	2
A	250	TYR	C-N	6.67	1.42	1.33	16	3
A	100	GLY	C-N	6.65	1.42	1.33	18	2
A	61	LYS	CA-CB	6.64	1.66	1.53	11	2
A	4	HIS	CB-CG	6.62	1.40	1.50	3	4
A	194	LEU	C-N	6.62	1.42	1.33	9	5
A	6	HIS	ND1-CE1	6.62	1.39	1.32	4	4
A	141	LEU	C-N	6.61	1.42	1.33	20	4
A	158	ARG	NE-CZ	6.59	1.25	1.33	5	5
A	14	GLY	C-N	6.59	1.42	1.33	8	2
A	225	LYS	C-N	6.58	1.42	1.33	13	4
A	103	GLU	C-N	6.57	1.42	1.33	3	2
A	177	PRO	N-CA	6.56	1.37	1.47	11	3
A	140	THR	N-CA	6.55	1.33	1.46	5	1
A	3	HIS	ND1-CE1	6.54	1.26	1.32	19	3
A	260	VAL	C-N	6.53	1.42	1.33	4	1
A	116	LYS	CA-C	6.53	1.39	1.52	19	2
A	7	HIS	CE1-NE2	6.50	1.39	1.32	14	7
A	56	VAL	C-N	6.50	1.42	1.33	3	3
A	175	GLU	CA-CB	6.46	1.66	1.53	8	1
A	209	ARG	CD-NE	6.45	1.55	1.46	8	4
A	152	PHE	C-N	6.41	1.42	1.33	17	2
A	124	LYS	C-N	6.41	1.42	1.33	4	4

Chain	Res	Type	Atoms	|Z|	Observed (Å)	Ideal (Å)	Model ID (Worst)	Models (Total)
A	206	ASP	C-N	6.38	1.42	1.33	15	3
A	3	HIS	CD2-NE2	6.34	1.44	1.37	3	3
A	276	LEU	CA-CB	6.32	1.66	1.53	18	1
A	91	ASN	C-N	6.30	1.42	1.33	12	2
A	198	ARG	CD-NE	6.28	1.55	1.46	17	5
A	83	ILE	C-N	6.28	1.42	1.33	5	1
A	86	ARG	CZ-NH2	6.28	1.25	1.33	8	3

Standard geometry: angle outliers

There are 3184 bond angle outliers in this entry (4.80% of 66380 assessed bonds). A summary is provided below. The output is limited to 100 rows.

Chain	Res	Type	Atoms	|Z|	Observed (Å)	Ideal (Å)	Model ID (Worst)	Models (Total)
A	47	ARG	NE-CZ-NH2	16.81	134.33	119.20	12	8
A	5	HIS	CA-CB-CG	13.93	99.87	113.80	8	7
A	130	ASP	CA-CB-CG	12.21	124.81	112.60	11	7
A	266	ASN	CA-CB-CG	11.81	124.41	112.60	16	6
A	122	ASP	CA-CB-CG	10.62	101.98	112.60	11	8
A	68	PHE	CA-CB-CG	10.54	103.26	113.80	20	7
A	179	GLN	OE1-CD-NE2	10.31	112.29	122.60	6	3
A	176	SER	CA-C-N	10.11	132.07	116.90	19	6
A	94	ASN	OD1-CG-ND2	10.10	132.70	122.60	18	9
A	42	ASN	CA-CB-CG	10.08	122.68	112.60	10	3
A	168	ASP	CA-CB-CG	10.07	102.53	112.60	6	8
A	226	ASP	CA-CB-CG	9.75	102.85	112.60	8	2
A	118	ASN	CA-CB-CG	9.70	102.90	112.60	6	5
A	4	HIS	CA-CB-CG	9.68	104.12	113.80	18	7
A	134	PHE	CA-CB-CG	9.52	123.32	113.80	5	9
A	241	PHE	CA-CB-CG	9.48	104.32	113.80	9	7
A	86	ARG	NE-CZ-NH1	9.47	130.97	121.50	20	5
A	9	ASN	OD1-CG-ND2	9.45	113.15	122.60	19	7
A	281	ASP	CA-CB-CG	9.45	103.15	112.60	16	7
A	70	ARG	NE-CZ-NH2	9.42	110.72	119.20	15	4
A	119	PHE	CA-CB-CG	9.40	104.40	113.80	15	8
A	86	ARG	NE-CZ-NH2	9.37	110.77	119.20	6	6
A	212	ARG	NE-CZ-NH2	9.14	110.97	119.20	12	4
A	256	ASN	CA-CB-CG	9.09	103.51	112.60	12	6

Chain	Res	Type	Atoms	|Z|	Observed (Å)	Ideal (Å)	Model ID (Worst)	Models (Total)
A	25	ARG	NE-CZ-NH2	9.05	127.35	119.20	7	7
A	308	ARG	NE-CZ-NH2	9.05	111.05	119.20	15	2
A	117	ASP	CA-CB-CG	9.05	103.55	112.60	14	7
A	38	ARG	NE-CZ-NH1	9.02	130.52	121.50	8	4
A	151	GLN	OE1-CD-NE2	8.91	113.69	122.60	16	7
A	142	PHE	CA-CB-CG	8.86	104.94	113.80	10	6
A	20	ASN	CA-CB-CG	8.84	121.44	112.60	16	5
A	19	PHE	CA-CB-CG	8.75	122.55	113.80	9	7
A	158	ARG	NE-CZ-NH1	8.71	130.21	121.50	14	8
A	6	HIS	ND1-CG-CD2	8.71	114.81	106.10	12	12
A	6	HIS	CB-CG-ND1	8.67	109.69	122.70	14	5
A	7	HIS	CA-CB-CG	8.65	105.15	113.80	17	7
A	55	ASN	CA-CB-CG	8.65	121.25	112.60	2	7
A	90	ASP	CA-CB-CG	8.63	103.97	112.60	7	8
A	102	GLN	OE1-CD-NE2	8.56	114.04	122.60	5	4
A	158	ARG	NE-CZ-NH2	8.53	111.53	119.20	17	8
A	167	ASP	CA-CB-CG	8.51	121.11	112.60	15	8
A	206	ASP	CA-CB-CG	8.49	121.09	112.60	6	9
A	256	ASN	OD1-CG-ND2	8.45	114.15	122.60	6	5
A	7	HIS	CB-CG-CD2	8.44	120.23	131.20	20	2
A	112	ARG	NE-CZ-NH1	8.41	129.91	121.50	14	9
A	3	HIS	CB-CG-ND1	8.36	110.16	122.70	12	4
A	6	HIS	CA-CB-CG	8.28	122.08	113.80	18	11
A	81	GLN	OE1-CD-NE2	8.28	114.32	122.60	14	4
A	25	ARG	NH1-CZ-NH2	8.27	108.55	119.30	7	3
A	112	ARG	NH1-CZ-NH2	8.22	108.61	119.30	19	4
A	3	HIS	CA-CB-CG	8.18	105.62	113.80	7	9
A	120	ASP	CA-CB-CG	8.18	104.42	112.60	19	8
A	9	ASN	CA-CB-CG	8.18	104.42	112.60	13	4
A	23	ASP	O-C-N	8.17	109.92	123.00	19	2
A	72	ASN	CA-CB-CG	8.15	120.75	112.60	13	9
A	6	HIS	CB-CG-CD2	8.15	141.79	131.20	14	6
A	81	GLN	CG-CD-NE2	8.13	128.60	116.40	11	1
A	71	ASP	CA-CB-CG	8.11	104.49	112.60	3	8
A	80	SER	C-N-CA	8.10	136.28	121.70	5	1

Chain	Res	Type	Atoms	|Z|	Observed (Å)	Ideal (Å)	Model ID (Worst)	Models (Total)
A	205	ALA	C-N-CA	8.07	136.23	121.70	10	3
A	142	PHE	CA-C-N	8.05	128.98	116.90	10	8
A	15	GLN	OE1-CD-NE2	8.02	114.58	122.60	19	3
A	91	ASN	CA-CB-CG	7.99	104.61	112.60	9	8
A	158	ARG	NH1-CZ-NH2	7.99	108.91	119.30	19	5
A	199	PHE	CA-CB-CG	7.98	105.82	113.80	20	5
A	200	ARG	NE-CZ-NH2	7.96	112.04	119.20	11	6
A	2	HIS	ND1-CG-CD2	7.91	114.01	106.10	13	8
A	29	ASN	CA-CB-CG	7.90	104.70	112.60	8	4
A	131	PHE	CA-CB-CG	7.88	105.92	113.80	17	8
A	308	ARG	NE-CZ-NH1	7.87	129.37	121.50	15	5
A	198	ARG	NE-CZ-NH2	7.85	112.14	119.20	12	9
A	25	ARG	NE-CZ-NH1	7.83	129.33	121.50	6	8
A	36	ASP	CA-CB-CG	7.82	120.42	112.60	10	8
A	58	GLY	C-N-CA	7.81	135.77	121.70	17	2
A	12	PHE	CA-CB-CG	7.78	121.58	113.80	12	5
A	214	GLN	OE1-CD-NE2	7.77	114.83	122.60	18	4
A	45	GLU	N-CA-CB	7.75	97.32	110.50	5	1
A	149	ASP	CA-CB-CG	7.71	120.31	112.60	20	7
A	195	ASN	CA-CB-CG	7.71	104.89	112.60	8	3
A	202	ASP	CA-CB-CG	7.70	120.30	112.60	12	8
A	209	ARG	NH1-CZ-NH2	7.68	109.32	119.30	5	7
A	79	TYR	C-N-CA	7.63	135.44	121.70	15	4
A	77	ASP	C-CA-CB	7.63	124.60	110.10	13	3
A	158	ARG	CA-C-N	7.61	128.32	116.90	9	6
A	294	ASP	CA-CB-CG	7.59	120.19	112.60	5	2
A	198	ARG	NH1-CZ-NH2	7.58	109.44	119.30	20	1
A	47	ARG	NE-CZ-NH1	7.57	129.07	121.50	11	6
A	215	GLN	OE1-CD-NE2	7.57	115.03	122.60	15	8
A	38	ARG	NE-CZ-NH2	7.55	112.41	119.20	8	6
A	149	ASP	N-CA-CB	7.52	97.71	110.50	18	2
A	153	SER	C-N-CA	7.51	135.21	121.70	19	1
A	189	ASN	CA-CB-CG	7.49	105.11	112.60	14	4
A	174	THR	CA-CB-OG1	7.49	120.83	109.60	11	6
A	198	ARG	NE-CZ-NH1	7.48	114.02	121.50	2	7

Chain	Res	Type	Atoms	|Z|	Observed (Å)	Ideal (Å)	Model ID (Worst)	Models (Total)
A	176	SER	CA-C-O	7.46	108.11	120.80	19	2
A	241	PHE	CB-CG-CD1	7.45	133.36	120.70	13	3
A	252	PHE	CA-CB-CG	7.45	121.25	113.80	15	7
A	209	ARG	NE-CZ-NH1	7.44	128.94	121.50	19	7
A	4	HIS	ND1-CG-CD2	7.44	113.54	106.10	19	12
A	195	ASN	OD1-CG-ND2	7.38	115.22	122.60	9	6

Too-close contacts

The following all-atom clashscore is based on a MolProbity analysis. All-atom clashscore is defined as the number of clashes found per 1000 atoms (including hydrogen atoms). The table below contains clashscores for all atomic models in this entry.

Model ID	Clash score	Number of clashes
1	0.21	1
2	1.25	6
3	1.67	8
4	0.84	4
5	1.25	6
6	0.63	3
7	0.42	2
8	0.21	1
9	0.42	2
10	1.04	5
11	0.63	3
12	0.84	4
13	1.25	6
14	1.25	6
15	0.21	1
16	0.21	1
17	0.21	1
18	0.63	3
19	0.42	2
20	1.04	5

There are 70 clashes. The table below contains the detailed list of all clashes based on a MolProbity analysis. Bad clashes are >= 0.4 Angstrom.

Atom 1	Atom 2	Clash(Å)	Model ID (Worst)	Models (Total)
A:197:ALA:HB2	A:216:VAL:HG21	0.60	14	1

Atom 1	Atom 2	Clash(Å)	Model ID (Worst)	Models (Total)
A:81:GLN:HE21	A:83:ILE:HD11	0.60	10	1
A:51:ILE:H	A:51:ILE:HD12	0.56	18	1
A:18:VAL:O	A:19:PHE:HB3	0.54	12	1
A:218:THR:HG23	A:268:ILE:HD12	0.53	4	2
A:68:PHE:CD1	A:115:LEU:HD11	0.53	15	1
A:15:GLN:CD	A:15:GLN:H	0.53	5	1
A:79:TYR:CE2	A:95:VAL:HG11	0.53	4	1
A:74:VAL:HG21	A:114:VAL:HG21	0.52	3	1
A:9:ASN:HD21	A:235:GLU:HG3	0.52	19	1
A:6:HIS:CE1	A:8:GLU:HB2	0.50	5	1
A:33:MET:HE1	A:111:VAL:HG21	0.50	6	1
A:125:TYR:CD2	A:248:VAL:HG22	0.50	6	1
A:162:GLU:HA	A:182:LYS:HA	0.50	11	1
A:271:LEU:HB2	A:305:MET:HE2	0.50	19	1
A:66:VAL:HG23	A:271:LEU:HB3	0.49	2	2
A:61:LYS:HG3	A:61:LYS:O	0.49	6	1
A:53:VAL:O	A:65:LEU:HD12	0.48	13	1
A:1:MET:HE3	A:7:HIS:CE1	0.48	11	1
A:34:GLY:HA3	A:131:PHE:CZ	0.47	13	1
A:121:LEU:HD21	A:307:LEU:HD13	0.47	13	1
A:279:TRP:CZ2	A:291:LEU:HD22	0.47	10	1
A:18:VAL:HA	A:247:ASN:HD22	0.47	2	1
A:3:HIS:CE1	A:6:HIS:CD2	0.47	10	1
A:7:HIS:CD2	A:250:TYR:CE2	0.46	12	1
A:52:MET:HE3	A:217:LEU:HD22	0.46	18	1
A:6:HIS:HE1	A:8:GLU:HB2	0.46	5	1
A:276:LEU:HA	A:279:TRP:CZ3	0.45	3	1
A:65:LEU:HG	A:268:ILE:HG21	0.45	10	1
A:248:VAL:HG11	A:253:LEU:HD21	0.45	9	1
A:164:THR:HA	A:180:THR:HA	0.45	4	3
A:105:GLN:HA	A:105:GLN:NE2	0.45	5	1
A:181:ILE:HD12	A:188:MET:HE2	0.44	3	1
A:7:HIS:CG	A:8:GLU:H	0.44	2	1
A:81:GLN:NE2	A:83:ILE:HD11	0.44	10	1
A:83:ILE:HD12	A:88:GLN:HG3	0.44	14	1

Atom 1	Atom 2	Clash(Å)	Model ID (Worst)	Models (Total)
A:138:ILE:HG21	A:193:LEU:HD22	0.43	12	1
A:112:ARG:NH1	A:113:GLN:HE22	0.43	14	1
A:183:VAL:HG22	A:184:GLY:N	0.42	3	1
A:42:ASN:O	A:43:SER:HB2	0.42	14	1
A:61:LYS:O	A:263:GLY:HA2	0.42	18	1
A:274:PRO:HB3	A:293:VAL:HG21	0.42	16	1
A:152:PHE:HB3	A:160:LEU:HD23	0.42	4	1
A:65:LEU:O	A:270:LYS:HA	0.42	20	1
A:74:VAL:HG22	A:91:ASN:O	0.41	7	1
A:248:VAL:HG22	A:249:PRO:HD2	0.41	12	1
A:162:GLU:HA	A:181:ILE:O	0.41	2	1
A:198:ARG:HD3	A:198:ARG:HH11	0.41	5	1
A:3:HIS:CG	A:4:HIS:N	0.41	9	1
A:146:VAL:O	A:187:GLN:HA	0.41	14	1
A:64:LYS:HB3	A:305:MET:HE2	0.41	2	1
A:30:ILE:HD11	A:127:ALA:HB2	0.41	3	1
A:198:ARG:O	A:200:ARG:HD2	0.41	20	1
A:252:PHE:C	A:252:PHE:CD1	0.41	13	1
A:65:LEU:HD23	A:270:LYS:HG2	0.41	13	2
A:207:TYR:CG	A:276:LEU:HB2	0.40	11	1
A:31:LEU:HB2	A:123:ILE:HG21	0.40	14	1
A:26:ASP:CG	A:59:SER:H	0.40	3	1
A:54:LEU:HD13	A:65:LEU:HD13	0.40	20	1
A:30:ILE:HG23	A:32:ILE:HD11	0.40	5	1
A:284:ASP:HB2	A:289:LEU:HB2	0.40	17	1
A:100:GLY:HA3	A:107:GLY:HA2	0.40	2	1
A:75:TYR:CD1	A:80:SER:HB2	0.40	13	1
A:236:ALA:O	A:240:VAL:HG23	0.40	3	1
A:268:ILE:O	A:270:LYS:HG3	0.40	20	1

Torsion angles: Protein backbone

In the following table, Ramachandran outliers are listed. The Analysed column shows the number of residues for which the backbone conformation was analysed.

Model ID	Analysed	Favored	Allowed	Outliers
1	306	283	16	7
2	306	290	13	3

Model ID	Analysed	Favored	Allowed	Outliers
3	306	289	11	6
4	306	283	19	4
5	306	286	16	4
6	306	285	18	3
7	306	274	27	5
8	306	284	17	5
9	306	289	15	2
10	306	283	20	3
11	306	287	16	3
12	306	274	26	6
13	306	289	16	1
14	306	276	26	4
15	306	283	21	2
16	306	279	21	6
17	306	289	14	3
18	306	289	16	1
19	306	278	22	6
20	306	287	15	4

There are 48 unique backbone outliers. Detailed list of outliers are tabulated below.

Chain	Res	Type	Models (Total)
A	4	HIS	4
A	19	PHE	4
A	43	SER	4
A	5	HIS	3
A	50	SER	3
A	105	GLN	3
A	153	SER	3
A	168	ASP	3
A	38	ARG	2
A	154	THR	2
A	177	PRO	2
A	200	ARG	2
A	233	GLY	2
A	249	PRO	2

Chain	Res	Type	Models (Total)
A	274	PRO	2
A	276	LEU	2
A	280	VAL	2
A	282	ALA	2
A	290	GLY	2
A	2	HIS	1
A	6	HIS	1
A	7	HIS	1
A	11	TYR	1
A	12	PHE	1
A	18	VAL	1
A	21	GLY	1
A	37	GLY	1
A	40	GLY	1
A	41	GLN	1
A	42	ASN	1
A	44	VAL	1
A	58	GLY	1
A	79	TYR	1
A	104	GLY	1
A	145	GLY	1
A	159	PRO	1
A	162	GLU	1
A	167	ASP	1
A	173	GLU	1
A	174	THR	1
A	175	GLU	1
A	203	ASP	1
A	205	ALA	1
A	224	ILE	1
A	226	ASP	1
A	234	SER	1
A	281	ASP	1
A	294	ASP	1

Torsion angles : Protein sidechains ?

In the following table, sidechain rotameric outliers are listed. The Analysed column shows the number of residues for which the sidechain conformation was analysed.

Model ID	Analysed	Favored	Allowed	Outliers
1	262	237	14	11
2	262	230	24	8
3	262	242	15	5
4	262	236	22	4
5	262	238	21	3
6	262	234	21	7
7	262	234	21	7
8	262	232	23	7
9	262	230	22	10
10	262	232	22	8
11	262	233	23	6
12	262	235	20	7
13	262	228	27	7
14	262	237	21	4
15	262	242	15	5
16	262	237	19	6
17	262	238	15	9
18	262	234	16	12
19	262	230	27	5
20	262	230	26	6

There are 77 unique sidechain outliers. Detailed list of outliers are tabulated below.

Chain	Res	Type	Models (Total)
A	1	MET	8
A	200	ARG	6
A	64	LYS	4
A	172	THR	4
A	251	THR	4
A	30	ILE	3
A	36	ASP	3
A	105	GLN	3
A	192	THR	3
A	202	ASP	3
A	227	PRO	3

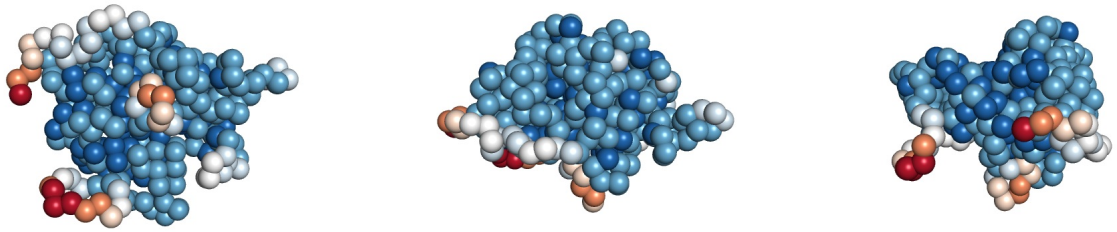
Chain	Res	Type	Models (Total)
A	291	LEU	3
A	307	LEU	3
A	16	VAL	2
A	32	ILE	2
A	41	GLN	2
A	47	ARG	2
A	74	VAL	2
A	84	ASN	2
A	90	ASP	2
A	102	GLN	2
A	136	THR	2
A	146	VAL	2
A	164	THR	2
A	177	PRO	2
A	178	THR	2
A	210	THR	2
A	216	VAL	2
A	243	MET	2
A	248	VAL	2
A	281	ASP	2
A	296	ASN	2
A	297	LYS	2
A	300	THR	2
A	304	GLN	2
A	308	ARG	2
A	10	LEU	1
A	19	PHE	1
A	20	ASN	1
A	24	THR	1
A	39	ILE	1
A	44	VAL	1
A	46	THR	1
A	55	ASN	1
A	70	ARG	1
A	72	ASN	1

Chain	Res	Type	Models (Total)
A	76	ILE	1
A	83	ILE	1
A	86	ARG	1
A	110	MET	1
A	112	ARG	1
A	128	LEU	1
A	132	GLN	1
A	151	GLN	1
A	152	PHE	1
A	154	THR	1
A	159	PRO	1
A	161	THR	1
A	168	ASP	1
A	169	LEU	1
A	170	TYR	1
A	174	THR	1
A	182	LYS	1
A	187	GLN	1
A	191	SER	1
A	213	GLN	1
A	223	GLN	1
A	228	THR	1
A	240	VAL	1
A	244	THR	1
A	252	PHE	1
A	254	LEU	1
A	266	ASN	1
A	270	LYS	1
A	279	TRP	1
A	285	VAL	1
A	293	VAL	1

4.2. PrISM Precision Analysis

*Regions of **low** **high** precision, defined as the variability among the models that satisfy the input data and calculated as the density-weighted root mean-square fluctuation (RMSF) from the bead/atom center of density, annotated and visualized using PrISM. The per-bead precision is computed from the deposited ensemble of superposed integrative models. High- and low-precision regions are then determined by clustering beads of similar precision based on their*

proximity in the structure. Only coarse-grained beads (or CA atoms for atomic models) of deposited models are used for assessment and visualization, and three projections for each representative model are generated.
PrISM analysis for Ensemble 1 (models deposited/total: 20/1000).



5. Fit to Data Used for Modeling Assessment

5.4. NMR

Validation for this section is under development.

6. Fit to Data Used for Validation Assessment

Validation for this section is under development.

Acknowledgments

The development of integrative model validation metrics, implementation of a model validation pipeline, and creation of a validation report for integrative structures are funded by NSF awards to the PDB-IHM team (DBI-1756248, DBI-2112966, DBI-2112967, DBI-2112968, and DBI-1756250) and awards from NSF, NIH, and DOE to the RCSB PDB (DBI-2321666, R01GM157729, and DE-SC0019749). The PDB-IHM team and members of the Sali lab contributed model validation metrics and software packages.

Dr. Jill Trewhella, Dr. Dina Schneidman, and members of the SASBDB repository are acknowledged for their advice and support in implementing SAS validation methods. Team members from the labs of Dr. Juri Rappsilber, Dr. Alexander Leitner, Dr. Andrea Graziadei, and members of PRIDE database are acknowledged for their advice and support in implementing crosslinking-MS validation methods. We are grateful to Dr. Shruthi Viswanath for discussions about uncertainty assessment of integrative structural models.

Members of the wwPDB Integrative/Hybrid Methods Task Force provided recommendations and community support for the project.