Integrative Structure Validation Report ?

October 09, 2025 - 04:46 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
pyHMMER Version 0.11.1

PDB ID	9A5U | pdb_00009a5u
PDB-Dev ID	PDBDEV_00000287
Structure Title	Integrative model of DLDH1-ODPB by crosslinking MS and deep learning
Structure Authors	Stahl, K.; Brock, O.; Rappsilber, J.
Deposited on	2024-01-23

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 ?

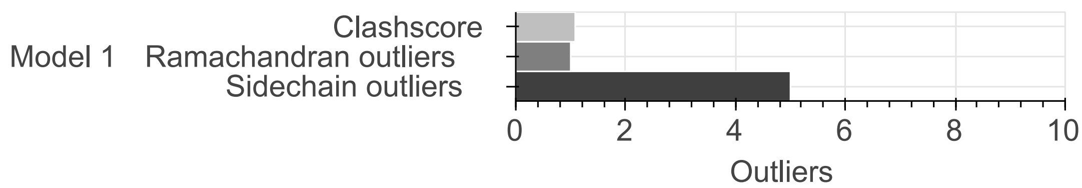
This entry consists of 1 model(s). A total of 1 dataset(s) were used to build this entry.

Name	Type	Count
Crosslinking-MS data	Experimental data	1

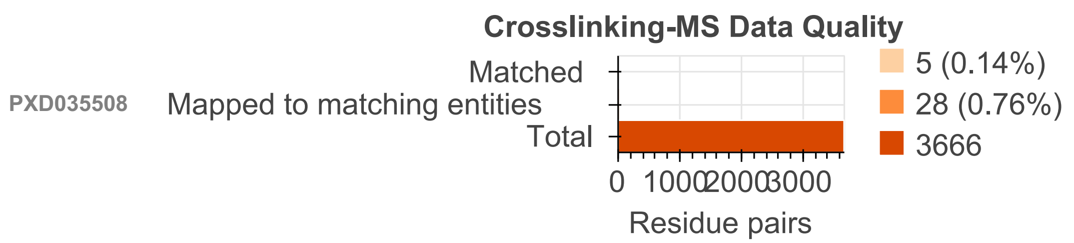
1.2. Overall quality ?

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.

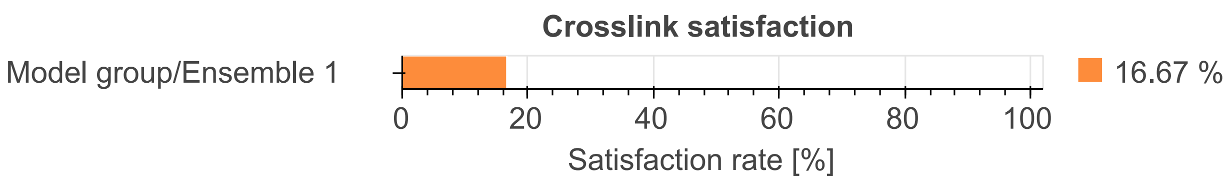
Model Quality: MolProbity Analysis



Data Quality



Fit to Data Used for Modeling



2. Model Details

2.1. Ensemble information

This entry consists of 0 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	1	DLDH1_BACSU	A	470	-	1-470	100.00 / 0.00	Atomic
		2	ODPB_BACSU	B	325	-	1-325	100.00 / 0.00	Atomic

2.3. Datasets used for modeling

There is 1 unique dataset used to build the models in this entry.

ID	Dataset type	Database name	Data access code
1	Crosslinking-MS data	PRIDE	PXD035508

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	AlphaLink2	AlphaLink2	Not available	1	False	False

There is 1 software package reported in this entry.

ID	Software name	Software version	Software classification	Software location
1	AlphaLink2	1.00	model building	https://github.com/Rappsilber-Laboratory/AlphaLink2

3. Data quality

3.2. Crosslinking-MS

At the moment, data validation is only available for crosslinking-MS data deposited as a fully compliant dataset in the PRIDE Crosslinking database. Correspondence between crosslinking-MS and entry entities is established using pyHMMER. Only residue pairs that passed the reported threshold are used for the analysis. The values in the report have to be interpreted in the context of the experiment (i.e. only a minor fraction of in-situ or in-vivo dataset can be used for modeling).

PXD035508

Number of entities in the crosslinking-MS dataset: 810

Number of entities in the entry: 2

Matching entities:

Entity ID	Molecule name	Crosslinking-MS Entity ID	E-value	Exact match
1	DLDH1_BACSU	dbseq_P21880_target	0.00	True
2	ODPB_BACSU	dbseq_P21882_target	0.00	True

Residue pairs stats:

Source	Total	In matched entities	Total matched
9A5U	6	6 (100.00%)	5 (83.33%)
PXD035508	3666	28 (0.76%)	5 (0.14%)

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 no bond length outliers.

Standard geometry: angle outliers

There are 13 bond angle outliers in this entry (0.16% of 8242 assessed bonds). A summary is provided below.

Chain	Res	Type	Atoms	|Z|	Observed (Å)	Ideal (Å)	Model ID (Worst)	Models (Total)
B	140	GLN	OE1-CD-NE2	5.27	117.33	122.60	1	1
A	315	ASP	CA-CB-CG	5.12	117.72	112.60	1	1
A	89	GLN	OE1-CD-NE2	4.92	117.68	122.60	1	1
B	173	HIS	CB-CG-CD2	4.85	124.89	131.20	1	1
A	73	ASP	CA-CB-CG	4.77	117.37	112.60	1	1
A	280	ASP	CA-CB-CG	4.70	117.30	112.60	1	1
A	324	HIS	CB-CG-CD2	4.48	125.37	131.20	1	1
A	131	ASP	CA-CB-CG	4.38	116.98	112.60	1	1
A	286	GLN	OE1-CD-NE2	4.37	118.23	122.60	1	1
B	266	GLN	OE1-CD-NE2	4.23	118.37	122.60	1	1
A	60	ASN	OD1-CG-ND2	4.08	118.52	122.60	1	1
B	280	ARG	CD-NE-CZ	4.05	130.08	124.40	1	1
B	303	GLN	OE1-CD-NE2	4.05	118.55	122.60	1	1

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	1.08	13

There are 13 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:380:LYS:HE3	A:398:PHE:CD1	0.64	1	1
A:413:ALA:HB1	A:427:LEU:HD13	0.64	1	1
A:56:LYS:HE3	A:354:PHE:CD1	0.61	1	1

Atom 1	Atom 2	Clash(Å)	Model ID (Worst)	Models (Total)
A:56:LYS:CE	A:354:PHE:CD1	0.57	1	1
A:380:LYS:HE3	A:398:PHE:CG	0.55	1	1
A:56:LYS:HE2	A:354:PHE:CE1	0.49	1	1
A:325:LYS:HE2	A:329:GLU:OE2	0.48	1	1
B:63:ILE:HG22	B:79:MET:HE3	0.47	1	1
A:435:MET:HE2	A:439:ASP:HB3	0.41	1	1
B:125:THR:HG21	B:174:MET:HE1	0.41	1	1
A:38:VAL:HG11	A:119:ALA:HB2	0.41	1	1
A:403:THR:HG21	A:437:ALA:HB2	0.40	1	1
A:27:ARG:NH1	A:335:GLU:OE2	0.40	1	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	791	771	19	1

There are 1 unique backbone outliers. Detailed list of outliers are tabulated below.

Chain	Res	Type	Models (Total)
B	237	ARG	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	636	610	21	5

There are 5 unique sidechain outliers. Detailed list of outliers are tabulated below.

Chain	Res	Type	Models (Total)
A	37	VAL	1
A	42	THR	1
A	139	THR	1
A	210	GLU	1
A	282	LEU	1

5. Fit to Data Used for Modeling Assessment ?

5.2. Crosslinking-MS

5.2.1. Restraint types

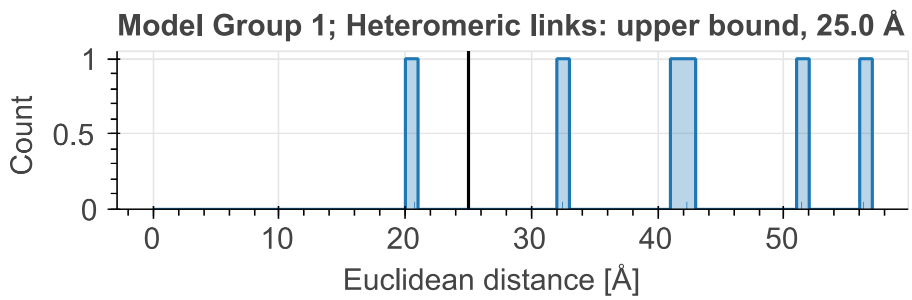
This table summarizes information about crosslinker(s) used for data generation, and how crosslinking information was translated into actual modeling restraints. Restraints assigned "by-residue" are interpreted as between CA atoms. Restraints between coarse-grained beads are indicated as "coarse-grained". Restraint group represents a set of crosslinking restraints applied collectively in the modeling.

There are 6 crosslinking restraints combined in 6 restraint groups.

Linker	Residue 1	Atom 1	Residue 2	Atom 2	Restraint type	Distance, Å	Count
SDA	LYS	CA	LYS	CA	upper bound	25.00	5
SDA	LYS	CA	VAL	CA	upper bound	25.00	1

Distograms of individual restraints

Distograms (i.e., histogram plots of distances) provide an overview of distributions of distances between residues for which chemical crosslinks were identified. The shift of the distogram relative to the threshold value may indicate a poor model. Restraints with identical thresholds are grouped into one plot. Only the best distance per restraint per model group/ensemble is plotted. Inter- and intramolecular (including self-links) restraints are also grouped into one plot. Distance for a restraint between coarse-grained beads is calculated as a minimal distance between shells; if beads intersect, the distance will be reported as 0.0. A bead with the highest available resolution for a given residue is used for the assessment.



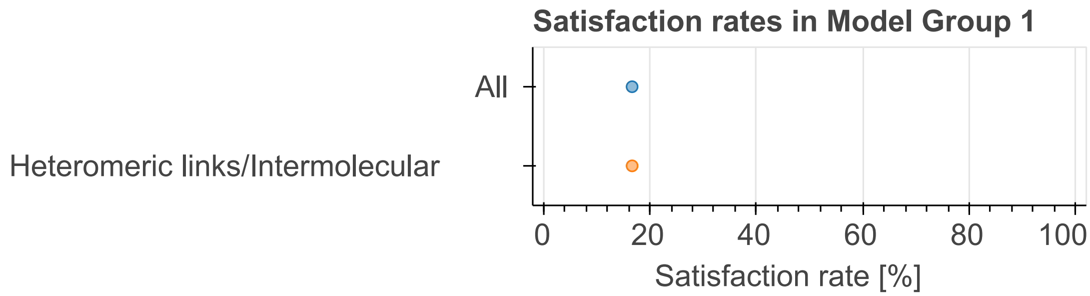
5.2.2. Satisfaction of restraints

Satisfaction of restraints is calculated on a restraint group (a set of crosslinking restraints applied collectively in the modeling) level. Satisfaction of a restraint group depends on satisfaction of individual restraints in the group and the conditionality (all/any). A restraint group is considered satisfied, if the condition was met in at least one model of the model group/ensemble. The number of measured restraints can be smaller than the total number of restraint groups if crosslinks involve non-modeled residues. Only deposited models are used for validation right now.

State group	State	Model group	# of Deposited models/Total	Restraint group type	Satisfied (%)	Violated (%)	Count (Total=6)
1	1	1	1/1	All	16.67	83.33	6
				Heteromeric links/ Intermolecular	16.67	83.33	6

Per-model satisfaction rates in ensembles

Every point represents one model in a model group/ensemble. Where possible, boxplots with quartile marks are also plotted.



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.