

Reporting Summary

Nature Portfolio wishes to improve the reproducibility of the work that we publish. This form provides structure for consistency and transparency in reporting. For further information on Nature Portfolio policies, see our [Editorial Policies](#) and the [Editorial Policy Checklist](#).

Statistics

For all statistical analyses, confirm that the following items are present in the figure legend, table legend, main text, or Methods section.

n/a Confirmed

- The exact sample size (n) for each experimental group/condition, given as a discrete number and unit of measurement
- A statement on whether measurements were taken from distinct samples or whether the same sample was measured repeatedly
- The statistical test(s) used AND whether they are one- or two-sided
Only common tests should be described solely by name; describe more complex techniques in the Methods section.
- A description of all covariates tested
- A description of any assumptions or corrections, such as tests of normality and adjustment for multiple comparisons
- A full description of the statistical parameters including central tendency (e.g. means) or other basic estimates (e.g. regression coefficient) AND variation (e.g. standard deviation) or associated estimates of uncertainty (e.g. confidence intervals)
- For null hypothesis testing, the test statistic (e.g. F , t , r) with confidence intervals, effect sizes, degrees of freedom and P value noted
Give P values as exact values whenever suitable.
- For Bayesian analysis, information on the choice of priors and Markov chain Monte Carlo settings
- For hierarchical and complex designs, identification of the appropriate level for tests and full reporting of outcomes
- Estimates of effect sizes (e.g. Cohen's d , Pearson's r), indicating how they were calculated

Our web collection on [statistics for biologists](#) contains articles on many of the points above.

Software and code

Policy information about [availability of computer code](#)

Data collection

Data analysis

For manuscripts utilizing custom algorithms or software that are central to the research but not yet described in published literature, software must be made available to editors and reviewers. We strongly encourage code deposition in a community repository (e.g. GitHub). See the Nature Portfolio [guidelines for submitting code & software](#) for further information.

Data

Policy information about [availability of data](#)

All manuscripts must include a [data availability statement](#). This statement should provide the following information, where applicable:

- Accession codes, unique identifiers, or web links for publicly available datasets
- A description of any restrictions on data availability
- For clinical datasets or third party data, please ensure that the statement adheres to our [policy](#)

Table 1 of the manuscript (EMDB IDs: EMD-27279, EMD-27280, EMD-27281, EMD-27282, EMD-27283, EMD-27284, EMD-27285, EMD-27286, EMD-27287, EMD-27288, EMD-27289, EMD-27290, EMD-27291, EMD-27292, EMD-27293, EMD-27294, EMD-27295). The protein models generated for this manuscript are available from the RCSB PDB (<https://www.rcsb.org/>) at the accession codes listed in Table 1 of the manuscript (PDB IDs: 8DBC, 8DBD, 8DBE, 8DBF, 8DBG, 8DBH, 8DBI, 8DBJ, 8DBK, 8DBL, 8DBM, 8DBN, 8DBO). Protein sequences identified by the NCBI online portal for BLAST (v2.13.0; <https://blast.ncbi.nlm.nih.gov/Blast.cgi>) were queried on the “non-redundant protein sequences (nr)” database. Source data are provided with this paper.

Human research participants

Policy information about [studies involving human research participants and Sex and Gender in Research](#).

Reporting on sex and gender	<input type="text" value="There were no human research participants in these studies."/>
Population characteristics	<input type="text" value="There were no human research participants in these studies."/>
Recruitment	<input type="text" value="There were no human research participants in these studies."/>
Ethics oversight	<input type="text" value="There were no human research participants in these studies."/>

Note that full information on the approval of the study protocol must also be provided in the manuscript.

Field-specific reporting

Please select the one below that is the best fit for your research. If you are not sure, read the appropriate sections before making your selection.

Life sciences Behavioural & social sciences Ecological, evolutionary & environmental sciences

For a reference copy of the document with all sections, see [nature.com/documents/nr-reporting-summary-flat.pdf](https://www.nature.com/documents/nr-reporting-summary-flat.pdf)

Life sciences study design

All studies must disclose on these points even when the disclosure is negative.

Sample size	<input type="text" value="For negative stain electron microscopy, two to three micrographs from different locations on a single grid were recorded and examined per condition, as is common in the field. The number of micrographs collected and particles included in final cryoEM structures are listed in Data Table 1. Unless otherwise noted, technical replicates of kinetic assays were performed in triplicate or greater, as is standard for the field."/>
Data exclusions	<input type="text" value="As is standard in cryoEM data analysis, particles that did not contribute to high resolution structure determination were excluded during 2D and 3D classification."/>
Replication	<input type="text" value="The number of replicates performed for the biochemical assays are listed in the figure legends."/>
Randomization	<input type="text" value="No grouping was performed in this study."/>
Blinding	<input type="text" value="As no grouping was performed in this study, no blinding was necessary."/>

Reporting for specific materials, systems and methods

We require information from authors about some types of materials, experimental systems and methods used in many studies. Here, indicate whether each material, system or method listed is relevant to your study. If you are not sure if a list item applies to your research, read the appropriate section before selecting a response.

Materials & experimental systems

n/a	Involved in the study
<input checked="" type="checkbox"/>	<input type="checkbox"/> Antibodies
<input checked="" type="checkbox"/>	<input type="checkbox"/> Eukaryotic cell lines
<input checked="" type="checkbox"/>	<input type="checkbox"/> Palaeontology and archaeology
<input checked="" type="checkbox"/>	<input type="checkbox"/> Animals and other organisms
<input checked="" type="checkbox"/>	<input type="checkbox"/> Clinical data
<input checked="" type="checkbox"/>	<input type="checkbox"/> Dual use research of concern

Methods

n/a	Involved in the study
<input checked="" type="checkbox"/>	<input type="checkbox"/> ChIP-seq
<input checked="" type="checkbox"/>	<input type="checkbox"/> Flow cytometry
<input checked="" type="checkbox"/>	<input type="checkbox"/> MRI-based neuroimaging