

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 (<i>n</i>) 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 <i>Only common tests should be described solely by name; describe more complex techniques in the Methods section.</i>
☒	☐ 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. <i>F</i> , <i>t</i> , <i>r</i>) with confidence intervals, effect sizes, degrees of freedom and <i>P</i> value noted <i>Give P values as exact values whenever suitable.</i>
☒	☐ 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 <i>d</i> , Pearson's <i>r</i>), 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	Immunoblotting images were captured with a LAS-4000UVmini Luminescent Image Analyzer (FUJIFILM); qRT-PCR analysis was performed on a Thermal Cycler Dice Real-Time System (Takara Bio); Microscopy images were captured with a ZEISS LSM 900 with Airyscan 2 (ZEISS).
Data analysis	The reads from RNA-seq data (DNBSEQ) were mapped to the genome using STARv2.6.0c. The reads from long-read direct RNA sequencing data were mapped to the human genome using Minimap2 (v2.17-r954-dirty). FLAIRv1.4.0 was used to correct the misaligned splicing junctions, to define the isoforms and to calculate the expression of alternative isoforms. The reads from RNA-seq data from NCBI's GEO or SRA were mapped to the genome using STARv2.7.10b. TPM were generated using RSEM v1.3.3. Statistical analysis was performed with R 4.3.1 or Microsoft Excel. Western blots images were analyzed using MultiGauge (FUJIFILM). Motif analysis was carried out using MEME v5.4.1 and Tomtom v5.4.1. TransDecoder v5.5.0 was used to predict coding sequence. BLASTp programs (version-2.12.0+) was used to search the similarity of the transcripts and predicted proteins. dSCOPE was used to predict the potential phase separation regions. Protein structure prediction was performed using AlphaFold Colab v2.3.2.

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](#)

RNA-seq data are deposited in the DNA Data Bank of Japan Sequence Read Archive (DRA) database (accession number: DRA014762). Source data are provided as a Source Data file.

Research involving human participants, their data, or biological material

Policy information about studies with [human participants or human data](#). See also policy information about [sex, gender \(identity/presentation\), and sexual orientation](#) and [race, ethnicity and racism](#).

Reporting on sex and gender	N/A
Reporting on race, ethnicity, or other socially relevant groupings	N/A
Population characteristics	N/A
Recruitment	N/A
Ethics oversight	N/A

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	No statistical method was used to predetermine sample size. At least three biological replicates were achieved for most of the experiments. Such sample sizes are typical for the in vitro experiments and sufficient for a statistical analysis.
Data exclusions	No data were excluded from the analysis.
Replication	The number of independent experiments performed is indicated in the figure legends.
Randomization	Randomization was done when possible. Cells were seeded identically at the onset of the experiments and randomized into the various treatment groups prior to beginning of treatment protocols.
Blinding	No behavioral experiment was performed; therefore, blinding was not implemented in this study.

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
☐	☒ Antibodies
☐	☒ Eukaryotic cell lines
☒	☐ Palaeontology and archaeology
☒	☐ Animals and other organisms
☒	☐ Clinical data
☒	☐ Dual use research of concern
☒	☐ Plants

Methods

n/a	Involved in the study
☒	☐ ChIP-seq
☒	☐ Flow cytometry
☒	☐ MRI-based neuroimaging

Antibodies

Antibodies used

Immunoblot:

Anti-MTR4 (Abclonal, A5576, Lot 0202580201, 1/1000)
 Anti-hnRNPK (Proteintech, 11426-1-AP, Lot 00022887, 1/1000)
 anti-PAPD5 (Proteintech, 55197-1-AP, Lot 09000346, 1/1000)
 Anti-GAPDH (Merck Millipore, MAB374, clone 6C5, Lot 3725986, 1/1000)
 Anti-ZFC3H1 (Novus Biologicals, NB100-68267, Lot R33689, 1/1000)
 Anti-EXOSC5 (Abcam, ab168804, Lot GR138334-1, 1/1000)
 Anti-PABPN1 (Abcam, ab75855, Lot GR32937-10, 1/1000)
 Anti-DIS3 (Sigma, HPA039281, Lot A95805, 1/1000)
 Anti-RBM7 (Sigma, HPA013993, Lot F119176, 1/1000)
 Anti-ZCCHC7 (Sigma, HPA021088, Lot A117087, 1/1000)
 Anti-ZCCHC8 (Sigma, SAB1102086, Lot 080M2750, 1/1000)
 Anti-FLAG (Sigma, F3165, clone M2, Lot 058K6113, 1/1000)
 Anti-UHRF1 (BD Biosciences, 612264, clone 28, Lot 83172, 1/1000)
 Anti- α -tubulin (CALBIOCHEM, CP-06, clone DM1A, Lot D00175772 1/1000)
 Anti-Rabbit IgG, HRP-Linked Whole Ab Donkey (GE Healthcare, NA934, Lot 9599347, 1:5000)
 Anti-Mouse IgG, HRP-Linked Whole Ab Sheep (GE Healthcare, NA931, Lot 384924, 1:5000)
 Anti-rabbit IgG HRP-linked Antibody (Cell Signaling, 7074S, Lot 29, 1:5000)

Immunoprecipitation, RNA Immunoprecipitation:

Anti-MTR4 (Abclonal, A5576, Lot 0202580201, 2 μ g per lysate)
 Anti-hnRNPK (Proteintech, 11426-1-AP, Lot 00022887, 1.375 μ g per lysate)
 Anti-FLAG M2 Magnetic Beads (Sigma, M8823, Lot 091M6291V, 10 μ L per lysate)
 Normal rabbit IgG (MBL, PM035, Lot 007, 2 μ g or 1.375 μ g per lysate)

Immunofluorescence:

Anti-FLAG (Sigma, F3165, clone M2, Lot 058K6113, 1/1000)
 Antiserum against human KCTD13 3XT Protein (Hokudo, 1/500)
 Goat anti-Mouse IgG (H+L) Highly Cross-Adsorbed Secondary Antibody, Alexa Fluor 488 (ThermoFisher Scientific, A11029, Lot 56649A, 1/1000)
 Donkey anti-Mouse IgG (H+L) Highly Cross-Adsorbed Secondary Antibody, Alexa Fluor 555 (ThermoFisher Scientific, A31570, Lot 2387458 1/1000)

Validation

All commercial antibodies except Antiserum against human KCTD13 3XT Protein were validated by the suppliers

Anti-MTR4 (<https://abclonal.com/catalog-antibodies/SKIV2L2RabbitAb/A5576>)
 Anti-hnRNPK (<https://www.ptglab.com/products/HNRNPK-Antibody-11426-1-AP.htm>)
 Anti-GAPDH (https://www.merckmillipore.com/JP/ja/product/Anti-Glyceraldehyde-3-Phosphate-Dehydrogenase-Antibody-clone-6C5,MM_NF-MAB374)
 Anti-ZFC3H1 (https://www.novusbio.com/products/psrc2-antibody_nb100-68267)
 Anti-EXOSC5 (<https://www.abcam.co.jp/products/primary-antibodies/exosc5cml28-antibody-ab168804.html>)
 Anti-PABPN1 (<https://www.abcam.co.jp/products/primary-antibodies/pabpn1-antibody-ep3000y-ab75855.html>)
 Anti-DIS3 (<https://www.sigmaaldrich.com/JP/ja/product/sigma/hpa039281>)
 Anti-RBM7 (<https://www.sigmaaldrich.com/JP/ja/product/sigma/hpa013993>)
 Anti-ZCCHC7 (<https://www.sigmaaldrich.com/JP/ja/product/sigma/hpa021088>)
 Anti-ZCCHC8 (Sigma, SAB1102086, <https://www.citeab.com/antibodies/1536903-sab1102086-anti-zcchc8-11-25-antibody-produced-in?des=24926770d3b430fc>)
 Anti-FLAG (<https://www.sigmaaldrich.com/US/en/product/sigma/f3165>)
 Anti-FLAG M2 Magnetic Beads (<https://www.sigmaaldrich.com/JP/en/product/sigma/m8823>)
 Anti-UHRF1 (<https://www.bdbiosciences.com/en-us/products/reagents/western-blotting-and-molecular-reagents/western-blot-reagents/purified-mouse-anti-icbp90.612264>)
 Anti- α -tubulin (<https://www.sigmaaldrich.com/US/en/product/mm/cp06>)
 Anti-Rabbit IgG, HRP-Linked Whole Ab Donkey (<https://www.cytivalifesciences.co.jp/catalog/0428.html>)

Anti-Mouse IgG, HRP-Linked Whole Ab Sheep (<https://www.cytivalifesciences.co.jp/catalog/0428.html>)

Anti-rabbit IgG HRP-linked Antibody (<https://www.cellsignal.com/products/secondary-antibodies/anti-rabbit-igg-hrp-linked-antibody/7074>)

Antiserum against human KCTD13 3XT Protein were validated by ELISA

Donkey anti-Mouse IgG (H+L) Highly Cross-Adsorbed Secondary Antibody, Alexa Fluor™ 555 (<https://www.thermofisher.com/antibody/product/Donkey-anti-Mouse-IgG-H-L-Highly-Cross-Adsorbed-Secondary-Antibody-Polyclonal/A-31570>)

Goat anti-Mouse IgG (H+L) Highly Cross-Adsorbed Secondary Antibody, Alexa Fluor™ 488 (<https://www.thermofisher.com/antibody/product/Goat-anti-Mouse-IgG-H-L-Highly-Cross-Adsorbed-Secondary-Antibody-Polyclonal/A-11029>)

Eukaryotic cell lines

Policy information about [cell lines and Sex and Gender in Research](#)

Cell line source(s)

HeLa cells, Clontech (Takara), 631183

Authentication

HeLa cells were directly purchased from Takara

Mycoplasma contamination

No mycoplasma contamination was detected

Commonly misidentified lines
(See [ICLAC](#) register)

No commonly misidentified cell lines were used in this study