

## Reporting Summary

Nature Research 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 Research policies, see [Authors & Referees](#) 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

n.a.

Data analysis

n.a.

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/reviewers. We strongly encourage code deposition in a community repository (e.g. GitHub). See the Nature Research [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 list of figures that have associated raw data
- A description of any restrictions on data availability

The datasets generated during and/or analyzed during the current study are available from the corresponding author on reasonable request. The source data underlying Supplementary Figs. 1a,c and 2c are provided as a Source Data file.

### 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

## Life sciences study design

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

Sample size	<input type="text" value="We used at least 10 embryos in two or more independent experiments."/>
Data exclusions	<input type="text" value="No data were excluded."/>
Replication	<input type="text" value="All experimental results were confirmed by two or more independent experiments."/>
Randomization	<input type="text" value="We randomly pick animals for experiments."/>
Blinding	<input type="text" value="We prepared control and experimental embryos by our hands, and therefore blinding is not possible."/>

## 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	Involvement in the study
<input type="checkbox"/>	<input checked="" type="checkbox"/> Antibodies
<input checked="" type="checkbox"/>	<input type="checkbox"/> Eukaryotic cell lines
<input checked="" type="checkbox"/>	<input type="checkbox"/> Palaeontology
<input type="checkbox"/>	<input checked="" type="checkbox"/> Animals and other organisms
<input checked="" type="checkbox"/>	<input type="checkbox"/> Human research participants
<input checked="" type="checkbox"/>	<input type="checkbox"/> Clinical data

### Methods

n/a	Involvement 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

## Antibodies

Antibodies used	<input type="text" value="anti-dpERK (Sigma, M9692); anti-GFP antibody (Thermo-Fisher Scientific, A6455)"/>
Validation	<input type="text" value="The anti-dpERK antibody has been used previously in many studies including the followings: Davidson et al. doi: 10.1101/gad.1467706, Genes &amp; Dev. 2006. 20: 2728-2738; Wagner and Levine, doi: 10.1242/dev.078485, Development 2012 139:2351-2359; Haupaix et al., doi:10.1242/dev.098756, Development 2013 140:4347-4352; Ohta and Satou, doi:10.1371/journal.pgen.1003818, Plos Genetics 2013&lt;br/&gt;The anti-GFP antibody is widely used for detecting GFP protein exogenously introduced. See more information for the manufacturer's web site."/>

## Animals and other organisms

Policy information about [studies involving animals](#); [ARRIVE guidelines](#) recommended for reporting animal research

Laboratory animals	<input type="text" value="NA"/>
Wild animals	<input type="text" value="We obtained animals through the National Bio-Resource project in Japan. In this project, wild animals are caught in Miyagi and Fukushima prefecture annually, and bred in Kyoto and Kanagawa prefectures in Japan. See more information for http://nbrp.jp."/>
Field-collected samples	<input type="text" value="NA"/>
Ethics oversight	<input type="text" value="Ciona intestinalis is excluded from legislation regulating scientific research on animals in Japan."/>

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