nature portfolio

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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	Gatan Microscopy Suite Software, Leica LAS AF Lite, Living Image, Imaging Lab, Chirascan, ITC run, Lumerical FDTD Solutions, 3D graphic, MATLAB, VESTA 3, xtb, tda.
Data analysis	OriginPro 8.5, Microsoft excel, GraphPad prism, NanoAnalyze, CytExpert

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

Provide your data availability statement here.

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

Life sciences study design

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

Sample size	All the experiments were performed in three replicated or more. Sample sizes for experiments were estimated based on previous experience with a similar setup that showed significance. For cell experiments, 1000000 cells were collected for each sample. Statistics were derived when at least 3 independent samples were analyzed. Experiments involved mice were divided into 56 groups, while 5 animals being analyzed for each group and each group was performed three replicated.
Data exclusions	No data was excluded from the analyzes.
Replication	For each experiment and condition, at least three independent technical replicates were performed with similar results. All observations reported in the manuscript were reproducible.
Randomization	The mice applied in this experiment were randomly selecting and divided into different groups, each group contain five mice.
Blinding	The investigators were blinded to group allocation during data collection and/or analysis. All samples were analyzed using the reported approach without prior knowledge of their levels.

Behavioural & social sciences study design

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

Study description	*Briefly describe the study type including whether data are quantitative, qualitative, or mixed-methods (e.g. qualitative cross-sectional, quantitative experimental, mixed-methods case study).*
Research sample	*State the research sample (e.g. Harvard university undergraduates, villagers in rural India) and provide relevant demographic information (e.g. age, sex) and indicate whether the sample is representative. Provide a rationale for the study sample chosen. For studies involving existing datasets, please describe the dataset and source.*
Sampling strategy	*Describe the sampling procedure (e.g. random, snowball, stratified, convenience). Describe the statistical methods that were used to predetermine sample size OR if no sample-size calculation was performed, describe how sample sizes were chosen and provide a rationale for why these sample sizes are sufficient. For qualitative data, please indicate whether data saturation was considered, and what criteria were used to decide that no further sampling was needed.*
Data collection	*Provide details about the data collection procedure, including the instruments or devices used to record the data (e.g. pen and paper, computer, eye tracker, video or audio equipment) whether anyone was present besides the participant(s) and the researcher, and whether the researcher was blind to experimental condition and/or the study hypothesis during data collection.*
Timing	*Indicate the start and stop dates of data collection. If there is a gap between collection periods, state the dates for each sample cohort.*
Data exclusions	*If no data were excluded from the analyses, state so OR if data were excluded, provide the exact number of exclusions and the rationale behind them, indicating whether exclusion criteria were pre-established.*
Non-participation	*State how many participants dropped out/declined participation and the reason(s) given OR provide response rate OR state that no participants dropped out/declined participation.*
Randomization	*If participants were not allocated into experimental groups, state so OR describe how participants were allocated to groups, and if allocation was not random, describe how covariates were controlled.*

Ecological, evolutionary & environmental sciences study design

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

Study description	*Briefly describe the study. For quantitative data include treatment factors and interactions, design structure (e.g. factorial, nested, hierarchical), nature and number of experimental units and replicates.*

Research sample	*Describe the research sample (e.g. a group of tagged Passer domesticus, all Stenocereus thurberi within Organ Pipe Cactus National Monument), and provide a rationale for the sample choice. When relevant, describe the organism taxa, source, sex, age range and any manipulations. State what population the sample is meant to represent when applicable. For studies involving existing datasets, describe the data and its source.*
Sampling strategy	*Note the sampling procedure. Describe the statistical methods that were used to predetermine sample size OR if no sample-size calculation was performed, describe how sample sizes were chosen and provide a rationale for why these sample sizes are sufficient.*
Data collection	*Describe the data collection procedure, including who recorded the data and how.*
Timing and spatial scale	*Indicate the start and stop dates of data collection, noting the frequency and periodicity of sampling and providing a rationale for these choices. If there is a gap between collection periods, state the dates for each sample cohort. Specify the spatial scale from which the data are taken*
Data exclusions	*If no data were excluded from the analyses, state so OR if data were excluded, describe the exclusions and the rationale behind them, indicating whether exclusion criteria were pre-established.*
Reproducibility	*Describe the measures taken to verify the reproducibility of experimental findings. For each experiment, note whether any attempts to repeat the experiment failed OR state that all attempts to repeat the experiment were successful.*
Randomization	*Describe how samples/organisms/participants were allocated into groups. If allocation was not random, describe how covariates were controlled. If this is not relevant to your study, explain why.*
Blinding	*Describe the extent of blinding used during data acquisition and analysis. If blinding was not possible, describe why OR explain why blinding was not relevant to your study.*

Did the study involve field work? ☐ Yes ☐ No

Field work, collection and transport

Field conditions	*Describe the study conditions for field work, providing relevant parameters (e.g. temperature, rainfall).*
Location	*State the location of the sampling or experiment, providing relevant parameters (e.g. latitude and longitude, elevation, water depth).*
Access & import/export	*Describe the efforts you have made to access habitats and to collect and import/export your samples in a responsible manner and in compliance with local, national and international laws, noting any permits that were obtained (give the name of the issuing authority, the date of issue, and any identifying information).*
Disturbance	*Describe any disturbance caused by the study and how it was minimized.*

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
☐	☐ Human research participants
☐	☐ Clinical data
☐	☐ Dual use research of concern

Methods

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

Antibodies

Antibodies used	FITC CD11c Monoclonal Antibody (ThermoFisher, 11-0114-85, N418), PerCP/Cyanine 5.5 Anti-mouse CD40 Antibody (Biolegend, 124623, 3/23), PE CD80 Monoclonal Antibody (ThermoFisher, 12-0801-81, 16-10A1), APC CD86 Monoclonal Antibody (ThermoFisher, 17-0862-82, GL1), FITC CD3e Monoclonal Antibody (ThermoFisher, 11-0031-82, 145-2C11), APC CD8a Monoclonal Antibody (ThermoFisher, 17-0081-82, 53-6.7), PE-Cy7 Rat Anti-mouse TNF (ThermoFisher, 25-7321-82, MP6-XT22), PerCP-Cyanine 5.5 IFN-γ Monoclonal Antibody (BD Pharmingen, 557649, XMG1.2), PE Anti-Mouse IL-4 Antibody (Biolegend, 504103, 11B11), PE CD44 Monoclonal Antibody (ThermoFisher, 12-0441-82, IM7), PE-Cyanine 7 CD62L Monoclonal Antibody (ThermoFisher, 25-0612-82, MEL-14), Horseradish Peroxidase-conjugated Anti-Mouse IgG (Thermo Fisher Scientific, 62-6520), IL-12 (BD, 555256), EEA1 Anti-mouse Monoclonal Antibody (Santa Cruz Biotechnology, sc-137130), LAMP1 Anti-mouse Monoclonal Antibody (Santa Cruz Biotechnology, sc-20011), Dynamin 2 Anti-rabbit Polyclonal Antibody (Abcam, ab3457), Clathrin Heavy Chain Anti-mouse Monoclonal

Antibody (ThermoFisher, MA1-065), Anti-CD97 Mouse Monoclonal Antibody (Sino Biological, 11280-MM07), Anti-CD97 Mouse Monoclonal Antibody (Santa Cruz Biotechnology, sc-166852), Anti-EMR1 Mouse Monoclonal Antibody (Santa Cruz Biotechnology, sc-365340, D-11), Anti-TLR4 Rabbit polyclonal Antibody (Abcam, ab13556), Anti-NLRP3 Rabbit Antibody (Invitrogen, PA5-79740), Caspase-1 Anti-mouse IgG (Santa Cruz Biotechnology, sc-56036), Anti-β-actin Mouse Monoclonal Antibody (Santa Cruz Biotechnology, sc-47778), Anti-IL-18 Rabbit polyclonal Antibody (Abcam, ab71495), Anti-IL-1 beta Rabbit Polyclonal Antibody (Sino Biological, 50101-T48),Anti-IL1β Rabbit Polyclonal Antibody (solarbio, K009661P), IL-18 (E8P5O) Rabbit mAb (Cell Signaling Technology, 57058S), Cleaved Caspase-1 (Asp296) (E2G2I) Rabbit mAb (Cell Signaling Technology, 89332), Anti-GSDMD Rabbit Polyclonal Antibody (solarbio, K009328P), Cleaved Gasdermin D (Asp276) Antibody (Cell Signaling Technology, 50928)

Validation

FITC CD11c Monoclonal Antibody (Species Reactivity: Human, Mouse; Application: Flow, ICC, IF, IHC, IV), PerCP/Cyanine 5.5 Anti-mouse CD40 Antibody (Species Reactivity: Mouse; Application: Flow), PE CD80 Monoclonal Antibody (Species Reactivity: Pig, Mouse, Dog; Application: Flow, ICC, IF, IHC, IV), APC CD86 monoclonal Antibody (Species Reactivity: Mouse; Application: Flow), FITC CD3e Monoclonal Antibody (Species Reactivity: Mouse; Application: Flow, ICC, IF, IHC), APC CD8a Monoclonal Antibody (Species Reactivity: Mouse; Application: Flow), PE-Cy7 Rat Anti-mouse TNF (Species Reactivity: Mouse; Application: Flow), PerCP-Cyanine5.5 IFN-γ Monoclonal Antibody (Species Reactivity: Mouse; Application: Flow), PE anti-mouse IL-4 antibody (Species Reactivity: Mouse; Application: Flow), PE CD44 Monoclonal Antibody (Species Reactivity: Mouse; Application: Flow), PE-Cyanine 7 CD62L Monoclonal Antibody (Species Reactivity: Mouse; Application: Flow), anti-EMR1 (Species Reactivity: Mouse; Application: ELISA, IP, IF, WB), IL-12 (Species Reactivity: Mouse; Application: ELISA), HRP-conjugated Anti-mouse IgG (Species Reactivity: Mouse; Application: ELISA, IHC, WB, ICC, IHC), EEA1 Anti-mouse Monoclonal Antibody (Species Reactivity: Mouse, Rat, Human, Monkey; Application: WB, IP, IF, IHC, ELISA), LAMP1 Anti-mouse Monoclonal Antibody (Species Reactivity: Mouse, Rat, Human; Application: WB, IP, IF, FCM, IHC, ELISA), Dynamin 2 Anti-rabbit Polyclonal Antibody (Species Reactivity: Mouse, Rat, Human, Non-human primates; Application: ICC, WB, IHC-P), Clathrin Heavy Chain Anti-mouse Monoclonal Antibody (Species Reactivity: Bovine, Hamster, Human, Mouse, Non-human Primate, Rat; Application: IHC, WB, Flow, IP, IM, ICC), Anti-CD97 Mouse Monoclonal Antibody (Species Reactivity: Human; Application: ELISA, ICC/IF), Anti-CD97 Mouse Monoclonal Antibody (Species Reactivity: Mouse, Rat, Human; Application: IP, WB, IHC(P) , ELISA, IF, FCM), Anti-EMR1 Mouse Monoclonal Antibody (Species Reactivity: Human; Application: IP, WB, IHC(P) , ELISA, IF, FCM), Anti-TLR4 Rabbit Polyclonal Antibody (Species Reactivity: Mouse, Human, Recombinant Fragment; Application: WB, IHC-P, IHC-Fr, Flow Cyt), Anti-NLRP3 Rabbit Antibody (Species Reactivity: Mouse; Application: WB, IF, ICC, IHC(P), Flow Cyt), Caspase-1 Anti-mouse IgG (Species Reactivity: Mouse, Rat, Human; Application: WB, IP, IF, IHC), Anti-β-actin Mouse Monoclonal Antibody (Species Reactivity: Mouse, Rat, Human; Application: WB, IP, IF, IHC (P), ELISA), Anti-IL-18 Rabbit polyclonal Antibody (Species Reactivity: Mouse; Application: WB, IHC-P), Anti-IL-1 beta Rabbit Polyclonal Antibody (Species Reactivity: Mouse; Application: WB,ELISA), Anti-IL1β Rabbit Polyclonal Antibody (Species Reactivity: Human Mouse Rat Dog Horse Rabbit; Application: WB ELISA IHC-P IHC-F IF), IL-18 (E8P5O) Rabbit mAb (Species Reactivity: Mouse; Application: WB), Cleaved Caspase-1 (Asp296) (E2G2I) Rabbit mAb (Species Reactivity: Mouse; Application: WB,IP), Anti-GSDMD Rabbit Polyclonal Antibody (Species Reactivity: Human Mouse; Application: WB), Cleaved Gasdermin D (Asp276) Antibody (Species Reactivity: Mouse; Application: WB)

Eukaryotic cell lines

Policy information about cell lines

Cell line source(s)	Human bone-marrow-derived dendritic cells (BMDCs) were obtained from Procell Life Science&Technology Co.,Ltd.
Authentication	No cell lines authentication was performed.
Mycoplasma contamination	No testing for mycoplasma contamination was performed.
Commonly misidentified lines (See ICLAC register)	*Name any commonly misidentified cell lines used in the study and provide a rationale for their use.*

Palaeontology and Archaeology

Specimen provenance	No specimen were used.
Specimen deposition	No specimen were used.
Dating methods	No specimen were used.

☒ Tick this box to confirm that the raw and calibrated dates are available in the paper or in Supplementary Information.

Ethics oversight	No specimen were used.

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

Animals and other organisms

Policy information about studies involving animals; ARRIVE guidelines recommended for reporting animal research

Laboratory animals	Wild type C57BL/6 mice (8 weeks old) were obtained from Qinglong Mountain Animal Technology (Nanjing, China). NLRP3 knockout mice (NLRP3-/-) in C57BL/6 background were obtained from Cyagen Biosciences. After the study, the captive mice were killed by neck-breaking. Because it is the most common method of killing mice with minimal pain, in line with animal welfare.
Wild animals	No wild animals were used.
Field-collected samples	For in-vivo toxicity test, the liver and kidney were excised for hematoxylin and eosin staining. To evaluate the maturation of BMDCs

Field-collected samples	in-vivo, mice were euthanized and the inguinal lymph nodes collected to prepare single cell suspensions 36 h after immunization.To analyze immune responses, mice were euthanized and splenocytes were harvest 7 d post the last immunization. The immunized mice were challenged,with H9N2 influenza virus 14 days after immunization. 21 days after challenged, mice were euthanized and lungs were harvest for hematoxylin and eosin (H&E) staining.
Ethics oversight	All animal studies were performed according to institutional ethical guidelines and were approved by the Committee on Animal Welfare of Jiangnan University.

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

Human research participants

Policy information about studies involving human research participants

Population characteristics	No human research participants in this experiment.
Recruitment	No human research participants in this experiment.
Ethics oversight	No human research participants in this experiment.

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

Clinical data

Policy information about clinical studies

All manuscripts should comply with the ICMJE guidelines for publication of clinical research and a completed CONSORT checklist must be included with all submissions.

Clinical trial registration	No clinical studies in this experiment.
Study protocol	No clinical studies in this experiment.
Data collection	No clinical studies in this experiment.
Outcomes	No clinical studies in this experiment.

Dual use research of concern

Policy information about dual use research of concern

Hazards

Could the accidental, deliberate or reckless misuse of agents or technologies generated in the work, or the application of information presented in the manuscript, pose a threat to:

No	Yes	
☒	☐	Public health
☒	☐	National security
☒	☐	Crops and/or livestock
☒	☐	Ecosystems
☒	☐	Any other significant area

Experiments of concern

Does the work involve any of these experiments of concern:

No	Yes	
☒	☐	Demonstrate how to render a vaccine ineffective
☒	☐	Confer resistance to therapeutically useful antibiotics or antiviral agents
☒	☐	Enhance the virulence of a pathogen or render a nonpathogen virulent
☒	☐	Increase transmissibility of a pathogen
☒	☐	Alter the host range of a pathogen
☒	☐	Enable evasion of diagnostic/detection modalities
☒	☐	Enable the weaponization of a biological agent or toxin
☒	☐	Any other potentially harmful combination of experiments and agents

ChIP-seq

Data deposition

☐ Confirm that both raw and final processed data have been deposited in a public database such as GEO.

☐ Confirm that you have deposited or provided access to graph files (e.g. BED files) for the called peaks.

Data access links *May remain private before publication.*	No ChIP-seq were used in this experiment.
Files in database submission	No ChIP-seq were used in this experiment.
Genome browser session (e.g. UCSC)	No ChIP-seq were used in this experiment.

Methodology

Replicates	No ChIP-seq were used in this experiment.
Sequencing depth	No ChIP-seq were used in this experiment.
Antibodies	No ChIP-seq were used in this experiment.
Peak calling parameters	No ChIP-seq were used in this experiment.
Data quality	No ChIP-seq were used in this experiment.
Software	No ChIP-seq were used in this experiment.

Flow Cytometry

Plots

Confirm that:

☒ The axis labels state the marker and fluorochrome used (e.g. CD4-FITC).

☒ The axis scales are clearly visible. Include numbers along axes only for bottom left plot of group (a 'group' is an analysis of identical markers).

☒ All plots are contour plots with outliers or pseudocolor plots.

☒ A numerical value for number of cells or percentage (with statistics) is provided.

Methodology

Sample preparation	Provided in SI on page S11-12, S15-17
Instrument	Flow cytometry was performed on BD FACSAria II.
Software	Data were analyzed by FlowJo and GraphPad prism software.
Cell population abundance	Provided in SI on page S11-12, S15-17
Gating strategy	Provided in Figure share on Figshare Fig. 18, 20, 34

☐ Tick this box to confirm that a figure exemplifying the gating strategy is provided in the Supplementary Information.

Magnetic resonance imaging

Experimental design

Design type	No MRI imaging were used in this experiment.
Design specifications	No MRI imaging were used in this experiment.
Behavioral performance measures	No MRI imaging were used in this experiment.

Acquisition

Imaging type(s) — No MRI imaging were used in this experiment.

Field strength — No MRI imaging were used in this experiment.

Sequence & imaging parameters — No MRI imaging were used in this experiment.

Area of acquisition — No MRI imaging were used in this experiment.

Diffusion MRI ☐ Used ☒ Not used

Preprocessing

Preprocessing software — No MRI imaging were used in this experiment.

Normalization — No MRI imaging were used in this experiment.

Normalization template — No MRI imaging were used in this experiment.

Noise and artifact removal — No MRI imaging were used in this experiment.

Volume censoring — No MRI imaging were used in this experiment.

Statistical modeling & inference

Model type and settings — No MRI imaging were used in this experiment.

Effect(s) tested — No MRI imaging were used in this experiment.

Specify type of analysis: ☐ Whole brain ☐ ROI-based ☐ Both

Statistic type for inference (See Eklund et al. 2016) — No MRI imaging were used in this experiment.

Correction — *Describe the type of correction and how it is obtained for multiple comparisons (e.g. FWE, FDR, permutation or Monte Carlo).*

Models & analysis

n/a	Involved in the study
☐	☐ Functional and/or effective connectivity
☐	☐ Graph analysis
☐	☐ Multivariate modeling or predictive analysis

Functional and/or effective connectivity — No MRI imaging were used in this experiment.

Graph analysis — No MRI imaging were used in this experiment.

Multivariate modeling and predictive analysis — No MRI imaging were used in this experiment.