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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	Custom algorithms or software were not used in this study, and all data is analyzed by GraphPad Prism 9.
Data analysis	All data statistics and analysis were performed using GraphPad Prism 9.

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

The authors declare that the data supporting the findings of this study are available within the paper, the Supplementary Information and Source data.

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	The study explored the biosafety and recellularization capacity of PEG/PSBMA-DHV. Th sex and gender isn't a research variable in this study, thus sex and gender isn't applicable.
Reporting on race, ethnicity, or other socially relevant groupings	The study explored the biosafety and recellularization capacity of PEG/PSBMA-DHV. The race, ethnicity, or other socially relevant groupings were not research variables in this study, thus the race, ethnicity, or other socially relevant groupings were not applicable.
Population characteristics	This study does not involve relevant content about Population characteristics.
Recruitment	This study does not involve relevant content about Recruitment.
Ethics oversight	The study does not involve the above research and therefore does not require human Ethics oversight.

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

Life sciences study design

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

Sample size	No statistical methods were used to predetermine sample sizes. Sample sizes were based on pilot experiments conducted in the same laboratory and comparable to similar studies in the field. The precise number of human subjects and animals were indicated in the figure legend.
Data exclusions	No data were excluded from the analyses.
Replication	All experiments were successfully replicated at least in 3 independent experiments.
Randomization	The samples used in the experiment were also uniformly prepared and randomly used without artificial selection.Cells were randomly assigned to different groups and performed independently. Animals were randomly allocated to each group and performed independently.
Blinding	The evaluation and scoring of histopathology of HE, masson, EVG, von Kossa tissue sections and Immunofluorescence staining such as inos/CD163, CD31/vimentin were performed in a blinded fashion. At the same time, the abdominal aorta ultrasound of rats was also performed by blind method. In the other experiments, no blinding was used during allocation of experimental groups, because all data collection and analysis is quantitative and not qualitative in nature. To avoid introducing bias, samples were measured in a standardized way.

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	FITC Rabbit monoclonal to CD206 (MMR), biolegend, catalog: 141703， 0.125 μg per million cells in 100 μl volume according to the supplier's instructions Alexa Fluor® 488 Rabbit monoclonal [EPR17259] to CD31, abcam, catalog: ab305267， 1:50 dilution according to the supplier's instructions Alexa Fluor® 647 Rabbit monoclonal [EPR3776] to Vimentin - Cytoskeleton Marker, catalog: ab194719， 1:500 dilution according to the supplier's instructions Alexa Fluor® 488 Rabbit monoclonal [EPR19518] to CD163, catalog: ab313665， 1:100 dilution according to the supplier's instructions APC Rabbit monoclonal to iNOS, biolegend, catalog: 696807， 1:100 dilution according to the supplier's instructions
Validation	FITC Rabbit monoclonal to CD206 (MMR), biolegend, catalog: 141703 https://www.biolegend.com/en-us/products/fitc-anti-mouse-cd206-mmr-antibody-7318 Alexa Fluor® 488 Rabbit monoclonal [EPR17259] to CD31, abcam, catalog: ab305267 https://www.abcam.cn/products/primary-antibodies/alexa-fluor-488-cd31-antibody-epr17259-ab305267.html Alexa Fluor® 647 Rabbit monoclonal [EPR3776] to Vimentin - Cytoskeleton Marker, catalog: ab194719 https://www.abcam.cn/products/primary-antibodies/alexa-fluor-647-vimentin-antibody-epr3776-cytoskeleton-marker-ab194719.html Alexa Fluor® 488 Rabbit monoclonal [EPR19518] to CD163, catalog: ab313665 https://www.abcam.cn/products/primary-antibodies/alexa-fluor-488-cd163-antibody-epr19518-ab313665.html APC Rabbit monoclonal to iNOS, biolegend, catalog: 696807 https://www.biolegend.com/en-us/products/apc-anti-nos2-inos-antibody-22848

Eukaryotic cell lines

Policy information about cell lines and Sex and Gender in Research

Cell line source(s)	Human cord blood endothelial cell line cell line (HUVEC) and RAW264.7 cell line were supplied by the Cell Culture Center of the Chinese Academy of Medical Sciences (Shanghai, China). Rat bone marrow mesenchymal stem cells (BMSC) were purchased from Sanop, Wuhan, Hubei Province, China.
Authentication	The rat bone marrow mesenchymal stem cells were identified by CD90 or CD44 immunofluorescence, and the purity could reach more than 90%, and did not contain HIV-1, HBV, HCV, mycoplasma, bacteria, yeast and fungi.
Mycoplasma contamination	All cell lines tested negative for mycoplasma contamination.
Commonly misidentified lines (See ICLAC register)	None of any commonly misidentified cell lines used in this study.

Animals and other research organisms

Policy information about studies involving animals; ARRIVE guidelines recommended for reporting animal research, and Sex and Gender in Research

Laboratory animals	SD rats (male, 180-200 g) were used in this experimental were provided by Hubei Bainte Biotechnology Co., LTD, and maintained under standard conditions.
Wild animals	This study didn't involve wild animals.
Reporting on sex	This study didn't involve reporting on sex.
Field-collected samples	The study didn't involve field-collected samples.
Ethics oversight	All the animal experiments were performed in line with the guidelines of “The Care and Use of Laboratory Animals in Huazhong institutional animal care and use committee, IACUC number:3649.

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 ICMJEguidelines for publication of clinical research and a completedCONSORT checklist must be included with all submissions.

Clinical trial registration	This study does not involve the relevant content of this part.
Study protocol	This study does not involve the relevant content of this part.

Data collection	This study does not involve the relevant content of this part.
Outcomes	This study does not involve the relevant content of this part.

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

Plants

Seed stocks	This study didn't involve seed stocks.
Novel plant genotypes	This study didn't involve novel plant genotypes.
Authentication	*Describe any authentication procedures for each seed stock used or novel genotype generated. Describe any experiments used to assess the effect of a mutation and, where applicable, how potential secondary effects (e.g. second site T-DNA insertions, mosiacism, off-target gene editing) were examined.*

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	Raw264.7 macrophage cells were obtained from the Cell Culture Center of the Chinese Academy of Medical Sciences (Beijing, China). The cells were cultured in DMEM (high glucose, Hyclone, USA) supplemented with 10% FBS (Gibco, USA), 100 unit ml-1 penicillin and 100 μg ml-1 streptomycin (Biosharp, China) at 37 °C in a humidified incubator containing 5% CO2. Raw264.7 macrophages were cultured in 12-well plates overnight. In order to analyze the effect of different samples on macrophage phenotype. The different samples were put into the 12-well plates and cultured with macrophage for 48 h. And then, M2-polarized macrophages were labeled with FITC-anti mouse CD206 (Biolegend, UN, catalog # 141703) according to the supplier's instructions, and the proportion of M2-phenotype macrophage polarization was detected by flow cytometry (CytoFLEX, BD Biosciences, Oxford, UK).
Instrument	flow cytometry (CytoFLEX, BD Biosciences, Oxford, UK)
Software	Flow cytometry data were collected and analyzed using CytExpert and FlowJo-V10 software.
Cell population abundance	The Gating strategy is described below. The cell population abundance of P1 portal was about 80%, and that of P2 portal was about 90%.
Gating strategy	First, cell groups were circled with FSC-A as the horizontal coordinate and SSC-A as the vertical coordinate, which was set as PI gate. Then, using FSC-A as the horizontal coordinate and FSC-H as the vertical coordinate, the cells on the diagonal line were selected and set as gate P2. The untreated cells were detected by flow cytometry, and a gate was drawn in the graph with FITC as the horizontal coordinate and Conut as the vertical coordinate, and the proportion of CD206 positive cells was set to 0. Finally, flow cytometry was performed on DHV,GV,T-DHV,PEG-DHV and PEG/PSBMA-DHV treated cells.

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