

# Biomaterials Science

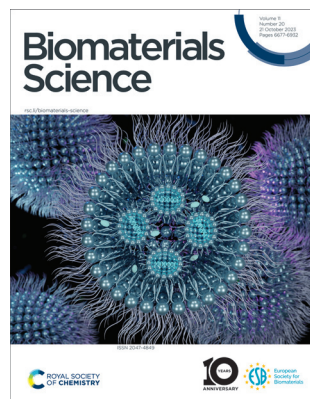
An international high impact journal exploring the underlying science behind the function, interactions and design of biomaterials

[rsc.li/biomaterials-science](https://rsc.li/biomaterials-science)

The Royal Society of Chemistry is the world's leading chemistry community. Through our high impact journals and publications we connect the world with the chemical sciences and invest the profits back into the chemistry community.

## IN THIS ISSUE

ISSN 2047-4849 CODEN BSICCH 11(20) 6677-6932 (2023)



© Love Employee/Getty Images

## EDITORIAL

6685

### Introduction to microneedles

Ryan Donnelly, Ester Caffarel-Salvador, Harvinder Gill and Hyungil Jung

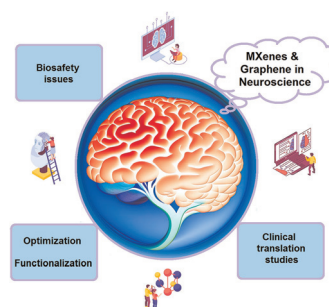


## REVIEWS

6687

### Graphene- and MXene-based materials for neuroscience: diagnostic and therapeutic applications

Atefeh Zarepour, Çimen Karasu, Yousof Mir, Mohammad Hadi Nematollahi,\* Siavash Iravani\* and Ali Zarrabi\*



## Editorial Staff

### Executive Editor

Maria Southall

### Deputy Editor

Laura Ghandhi

### Editorial Production Manager

Cara Sutton

### Assistant Editors

Sean Browner, Molly Colgate, Paul Scott, Alison Winder

### Editorial Assistant

Basita Javeed

### Publishing Assistant

Allison Holloway

### Publisher

Sam Keltie

For queries about submitted papers, please contact

Cara Sutton, Editorial Production Manager in the first instance.

E-mail: biomaterialsscience@rsc.org

For pre-submission queries please contact

Maria Southall, Executive Editor.

E-mail: biomaterialsscience-rsc@rsc.org

Biomaterials Science (electronic: ISSN 2047-4849) is published 24 times a year by the Royal Society of Chemistry, Thomas Graham House, Science Park, Milton Road, Cambridge, UK CB4 0WF.

All orders, with cheques made payable to the Royal Society of Chemistry, should be sent to the Royal Society of Chemistry Order Department, Royal Society of Chemistry, Thomas Graham House, Science Park, Milton Road, Cambridge, CB4 0WF, UK

Tel +44 (0)1223 432398; E-mail orders@rsc.org

2023 Annual (electronic) subscription price: £2450, \$4518.

Customers in Canada will be subject to a surcharge to cover GST.

Customers in the EU subscribing to the electronic version only will be charged VAT.

If you take an institutional subscription to any Royal Society of Chemistry journal you are entitled to free, site-wide web access to that journal. You can arrange access via Internet Protocol (IP) address at [www.rsc.org/ip](http://www.rsc.org/ip)

Customers should make payments by cheque in sterling payable on a UK clearing bank or in US dollars payable on a US clearing bank.

Whilst this material has been produced with all due care, the Royal Society of Chemistry cannot be held responsible or liable for its accuracy and completeness, nor for any consequences arising from any errors or the use of the information contained in this publication. The publication of advertisements does not constitute any endorsement by the Royal Society of Chemistry or Authors of any products advertised. The views and opinions advanced by contributors do not necessarily reflect those of the Royal Society of Chemistry which shall not be liable for any resulting loss or damage arising as a result of reliance upon this material. The Royal Society of Chemistry is a charity, registered in England and Wales, Number 207890, and a company incorporated in England by Royal Charter (Registered No. RC000524), registered office: Burlington House, Piccadilly, London W1J 0BA, UK, Telephone: +44 (0) 207 4378 6556.

### Advertisement sales:

Tel +44 (0) 1223 432246; Fax +44 (0) 1223 426017;

E-mail [advertising@rsc.org](mailto:advertising@rsc.org)

For marketing opportunities relating to this journal, contact [marketing@rsc.org](mailto:marketing@rsc.org)

# Biomaterials Science

[rsc.li/biomaterials-science](http://rsc.li/biomaterials-science)

An international high impact journal exploring the science of biomaterials and their translation towards clinical use.

## Editorial Board

### Editor-in-chief

Jianjun Cheng, Westlake University, China

### Associate Editors

Khuloud Al-Jamal, King's College London, UK

Nasim Annabi, University of California, Los Angeles, USA

Lino Ferreira, UC-Biotech, Portugal

Jöns Hilborn, Uppsala University, Sweden

Won Jong Kim, POSTECH, Korea

Shyni Varghese, Duke University, USA

Fu-Jian Xu, Beijing University of Chemical Technology, China

Lichen Yin, Soochow University, China

Can Zhang, China Pharmaceutical University, China

Chuan Zhang, Shanghai Jiao Tong University

### Editorial Board Members

Pamela Habibovic, Maastricht University, Netherlands

Xinyuan Zhu, Shanghai Jiao Tong University, China

## Advisory Board

Lihl Adler-Abramovich, Tel Aviv University, Israel

Kazunari Akiyoshi, iCeMS, Japan

Cameron Alexander, University of Nottingham, UK

Edmondo Benetti, ETH Zürich, Switzerland

Mark Bradley, University of Edinburgh, UK

Jayanta Chatterjee, IISC, India

Arabinda Chaudhuri, CSIR-Indian Institute of

Chemical Technology, India

Guoping Chen, National Institute for Materials

Science (NIMS), Japan

Yiyun Cheng, East China Normal University, China

Joel Collier, Duke University, USA

Justin Cooper-White, University of Queensland,

Australia

Honggang Cui, Johns Hopkins University, USA

Jianwu Dai, Institute of Genetics and

Developmental Biology of CAS, China

Cole DeForest, University of Washington, USA

Andrew Dove, University of Birmingham, UK

Yizhou Dong, The Ohio State University, USA

Hongwei Duan, Nanyang Technological University

(NTU), Singapore

Christine Dufes, University of Strathclyde, UK

Nicholas Dunne, Dublin City University, Ireland

Jennifer Elisseeff, Johns Hopkins University, USA

Elisabeth Engel Lopez, IBE, Spain

Shaoqin Sarah Gong, University of Wisconsin-

Madison, USA

Dong Keun Han, Cha University, Korea

Ngan Huang, Stanford, USA

Chris Jewell, University of Maryland, USA

Jian Ji, Zhejiang University, China

Ali Khademhosseini, Terasaki Institute for

Biomedical Innovation, USA

April Kloxin, University of Delaware, USA

Veena Koul, IIT Delhi, India

Christine Le Maitre, University of Sheffield, UK

Haeshin Lee, KAIST, Republic of Korea

Khoon Lim, University of Sydney, Australia

Matthias Lutolf, Ecole Polytechnique Fédérale de

Lausanne, Switzerland

Atsushi Maruyama, Tokyo Institute of Technology,

Japan

Phillip Messersmith, University of California,

Berkeley, USA

Aline Miller, University of Manchester, UK

Hyejung Mok, Konkuk University, Korea

Steve Oh, A\*STAR, Singapore

Shaunak Pandya, Prolong Pharmaceuticals, USA

Ling Peng, Aix-Marseille University, France

Nicholas Peppas, University of Texas at Austin, USA

Catherine Picart, Grenoble INP, France

Tilo Pompe, University of Leipzig, Germany

Suzie Pun, University of Washington, USA

Shun Shen, Tongji University, China

Heungsoo Shin, Hanyang University, Korea

Molly Shoichet, University of Toronto, Canada

Xintao Shuai, Sun Yat-Sen University, China

Aasheesh Srivastava, IISER, India

Patrick Stayton, University of Washington, USA

Marcus Textor, ETH Zurich, Switzerland

Takafumi Ueno, Tokyo Institute of Technology,

Japan

Jun Wang, South China University of Technology,

China

Tanja Weil, Max Planck Institute for Polymer

Research, Germany

Stephanie Willerth, University of Victoria, Canada

Zimei Wu, University of Auckland, New Zealand

Evelyn Yin, Waterloo, Canada

## Information for Authors

Full details on how to submit material for publication in Biomaterials Science are given in the Instructions for Authors (available from <http://www.rsc.org/authors>). Submissions should be made via the journal's homepage: [rsc.li/biomaterials-science](http://rsc.li/biomaterials-science). Submissions:

The journal welcomes submissions of manuscripts for publication as

Full Papers, Communications, Minireviews and Reviews. Full Papers and

Communications should describe original work of high quality and impact.

Additional details are available from the Editorial Office

or <http://www.rsc.org/authors>

Authors may reproduce/republish portions of their published contribution without seeking permission from the Royal Society of Chemistry, provided that any such republication is accompanied by an acknowledgement in the

form: (Original Citation)—Reproduced by permission of the Royal Society of Chemistry.

This journal is © The Royal Society of Chemistry 2023.

Apart from fair dealing for the purposes of research or private study for non-commercial purposes, or criticism or review, as permitted under the Copyright, Designs and Patents Act 1988 and the Copyright and Related Rights Regulation 2003, this publication may only be reproduced, stored or transmitted, in any form or by any means, with the prior permission in writing of the Publishers or in the case of reprographic reproduction in accordance with the terms of licences issued by the Copyright Licensing Agency in the UK. US copyright law is applicable to users in the USA.

Registered charity number: 207890

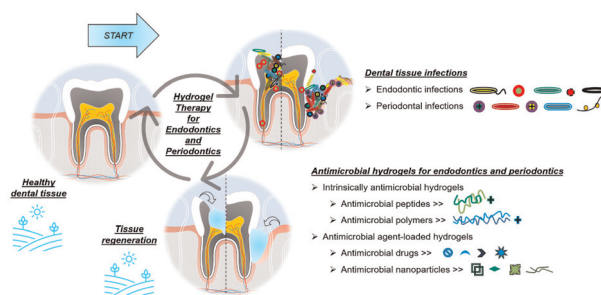


## REVIEWS

6711

## Advances in antimicrobial hydrogels for dental tissue engineering: regenerative strategies for endodontics and periodontics

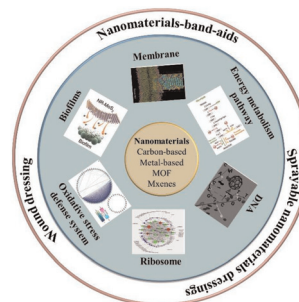
Deniz Atila\* and Vignesh Kumaravel\*



6748

## Recent advances in nanomaterial-mediated bacterial molecular action and their applications in wound therapy

Wanfeng Wu, Mengjiao Duan, Shuxuan Shao, Fanxing Meng, Yanan Qin\* and Minwei Zhang\*

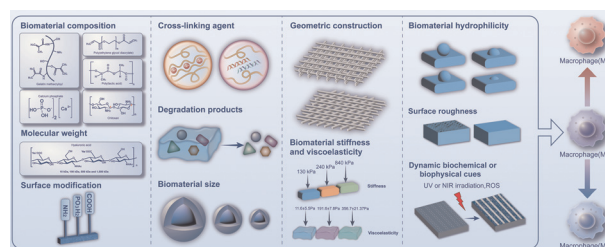


## COMMUNICATIONS

6770

## Multivalency-enhanced enzyme inhibitors with biomolecule-responsive activity

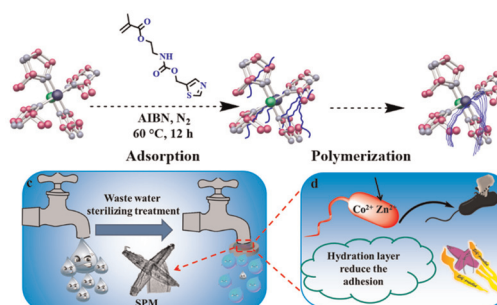
Fan Ding, Xinrui Li, Xu Chen, Yue Ma\* and Guoqing Pan\*



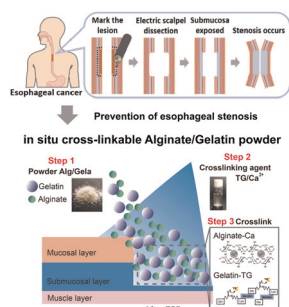
6775

## Construction of self-propelled micromotor for "hunting bacteria"

Yaping Zhang, Duoxin Zhang, Yuanze Geng, Yufeng He, Pengfei Song and Rongmin Wang\*



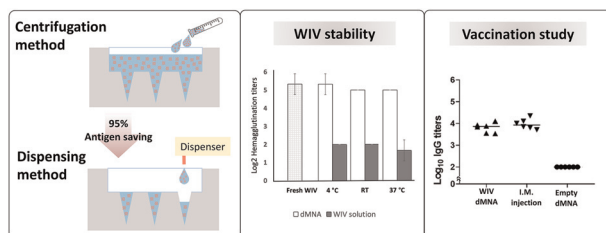
6781



### Prevention of esophageal stenosis *via in situ* cross-linkable alginate/gelatin powder in a new submucosal exfoliation model in rats

Qi Pan, Yosuke Tsuji, Athira Sreedevi Madhavikutty, Seiichi Ohta, Ayano Fujisawa, Natsuko F. Inagaki, Mitsuhiro Fujishiro and Taichi Ito\*

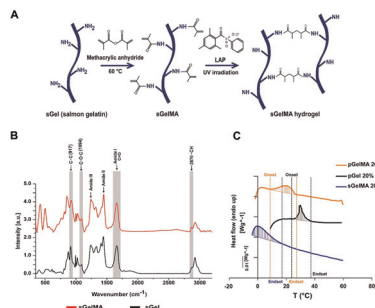
6790



### Efficient fabrication of thermo-stable dissolving microneedle arrays for intradermal delivery of influenza whole inactivated virus vaccine

Jihui Lee, Martin Beukema, Oliwia A. Zaplatynska, Conor O'Mahony, Wouter L. J. Hinrichs, Anke L. W. Huckriede, Joke A. Bouwstra and Koen van der Maaden\*

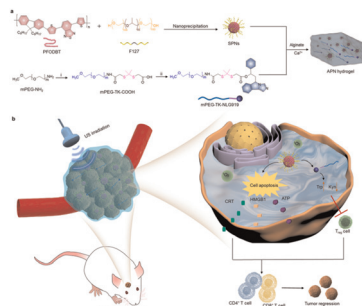
6801



### An advanced biphasic porous and injectable scaffold displays a fine balance between mechanical strength and remodeling capabilities essential for cartilage regeneration

Gabriela Zavala, Sergio M. Viafara-García, Javier Novoa, Carmen Hidalgo, Ingrid Contardo, Paulo Díaz-Calderón, Wilfredo Alejandro González-Arriagada, Maroun Khoury and Juan Pablo Acevedo\*

6823



### Prodrug-loaded semiconducting polymer hydrogels for deep-tissue sono-immunotherapy of orthotopic glioblastoma

Liyun Zhu, Xing Wang, Mengbin Ding, Ningyue Yu, Yijing Zhang, Hongwei Wu,\* Qin Zhang,\* Jiansheng Liu\* and Jingchao Li\*

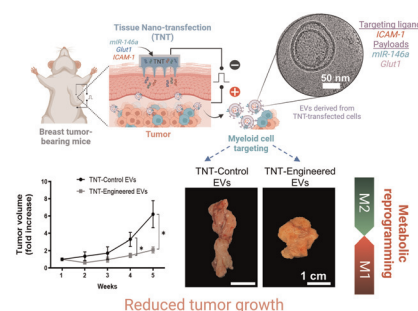


## PAPERS

6834

### ICAM-1-decorated extracellular vesicles loaded with miR-146a and *Glut1* drive immunomodulation and hinder tumor progression in a murine model of breast cancer

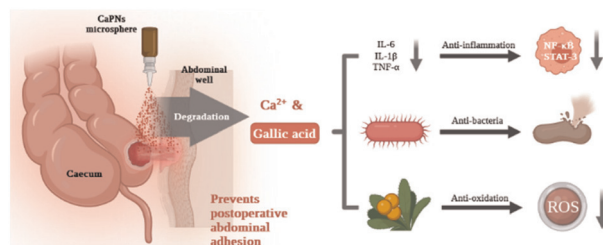
S. Duarte-Sanmiguel, A. I. Salazar-Puerta, A. Panic, D. Dodd, C. Francis, D. Alzate-Correa, L. Ortega-Pineda, L. Lemmerman, M. A. Rincon-Benavides, K. Dathathreya, W. Lawrence, N. Ott, J. Zhang, B. Deng, S. Wang, S. P. Santander, D. W. McComb, E. Reategui, A. F. Palmer, W. E. Carson, N. Higuera-Castro\* and D. Gallego-Perez\*



6848

### Multifunctional calcium polyphenol networks reverse the hostile microenvironment of trauma for preventing postoperative peritoneal adhesions

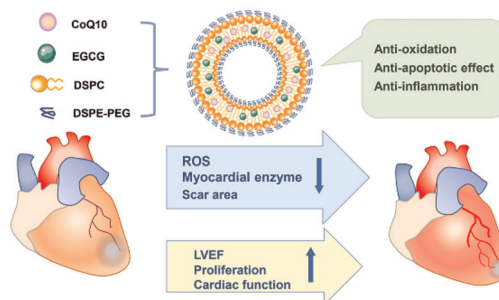
Pei Zhang, Yan Gong, Qingqing Pan, Zhenlin Fan, Genke Li, Mengyu Pei, Junhe Zhang, Tianyun Wang, Guangdong Zhou, Xiansong Wang\* and Wenjie Ren\*



6862

### Synergetic EGCG and coenzyme Q10 DSPC liposome nanoparticles protect against myocardial infarction

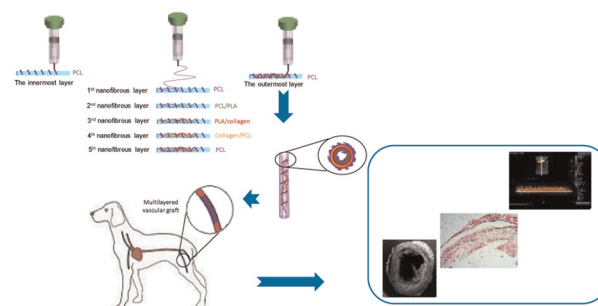
Wenrui Lei, Jie Yang, Junwei Wang, Zezhou Xiao, Pengyu Zhou, Shaoyi Zheng and Peng Zhu\*



6871

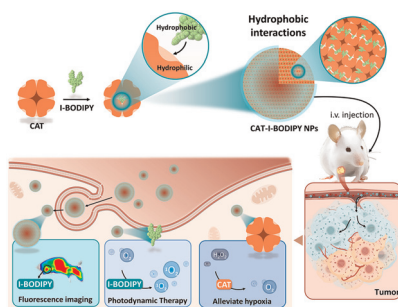
### Preclinical *in vivo* assessment of a cell-free multi-layered scaffold prepared by 3D printing and electrospinning for small-diameter blood vessel tissue engineering in a canine model

Mehdi Atari, Abbas Saroukhani, Maziar Manshaei, Peiman Bateni, Anousheh Zargar kharazi, Elham Vatankhah\* and Shaghayegh Haghjooy Javanmard\*





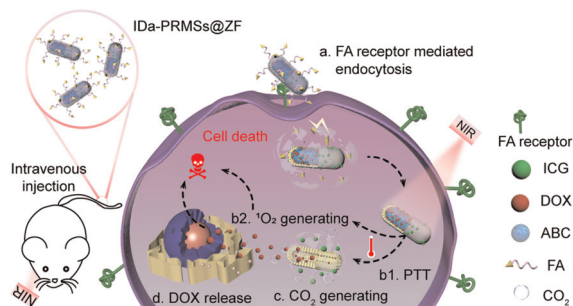
6881



### Multifunctional protein-based self-assembled nanoplateform: overcoming hypoxic tumor microenvironment for enhanced imaging-guided photodynamic therapy

Min Li, Ziyi Cheng, Heng Liu, Kun Dou, Huan Xiao,\*  
Linlu Zhao\* and Fabio Yu\*

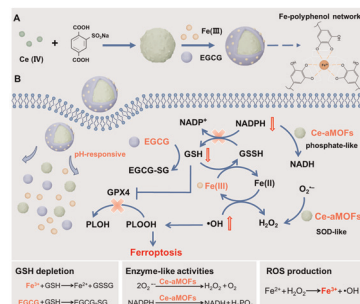
6894



### Functionalized nanohybrids with rod shape for improved chemo-phototherapeutic effect against cancer by sequentially generating singlet oxygen and carbon dioxide bubbles

Wei Zhang, Lu Chen, Xianbin Zhang, Peng Gong,  
Xiyu Wang, Zhiying Xu, Ganyu Nie and Lu Xu\*

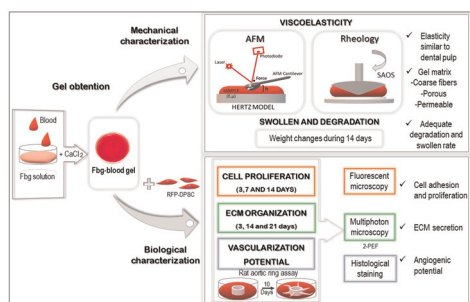
6906



### GSH-depleting metal-polyphenol-network nanoparticles with dual enzyme activities induce enhanced ferroptosis

Wen-Xin Zhang, You Li, Di Ke, Yi-Ru Gao, Teng Fei,  
Guo-Qing Wang, Yang Shu\* and Jian-Hua Wang\*

6919



### Biomechanical characterization of a fibrinogen-blood hydrogel for human dental pulp regeneration

Sofia Silvia Piglionico,\* Bela Varga, Orsolya Pall,  
Olivier Romieu, Csilla Gergely, Frédéric Cuisinier,  
Bernard Levallois and Ivan Vladislavov Panayotov

