Sushma Kumari

About the faculty

Dr. Sushma Kumari joined **VIT-Vellore** in 2022 as an **Assistant Professor Senior** at the Centre for Biomaterials, Cellular and Molecular Theranostics (**CBCMT**). She earned her **Ph.D. in Chemical Sciences** (**2009-2015**) from CSIR-NCL, Pune, where she worked extensively on the development of porous materials assembled from inorganic particles, bio-nanoparticles, and polymers, and explored their applications in bio-catalysis, detection, and signal amplification. She has **postdoctoral research** experience in biomaterials science and engineering from the **University of Bayreuth, Germany (2015-2019)** and the **Indian Institute of Science, Bangalore (2020-2022**), which has provided her a strong research base in biomaterials, antifouling materials, and 3D bioprinting to develop biomimetic materials. Her current area of research includes 3D bioprinting and microfluidic devices for biomedical applications, and antifouling materials.

Research Areas

- Biomaterial-based biomimetic 3D models for tissue engineering applications.
- 3D bioprinting for tissue engineering and in vitro models for drug testing applications.
- Fabrication of microfluidic chips for analysis of biospecies.
- Development of biopolymeric hybrid materials for antimicrobial applications

Contact Info:

E-mail: sushma.kumari@vit.ac.in, sushmakumari86@gmail.com

LinkedIn: https://www.linkedin.com/in/dr-sushma-kumari-0a9807a2?lipi=urn%3Ali%3Apage%3Ad_flagship3_profile_view_base_contact_details%3Be7is0KlfSiqIia%2BDUHIysg%3D%3D

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Research Interests

My research interests span a wide range of experimental interdisciplinary areas and include specialties of chemistry, materials, and nanotechnology. Different biopolymers exist with unique chemistry and structure, providing a library of biopolymers to create advanced materials utilizing nanomaterials and fabrication techniques. Through the combination of chemistry and materials, I aim to generate new biomaterials for regenerative medicine, drug delivery, and biomedical applications.

My research plans include the design of composite biomaterials with different fabrication techniques, characterization of materials, and *in vitro* cell based assays. Materials of my first research interests are as follows, but not limited to (1) responsive functional nano-based materials with antimicrobial properties for coating medical implant devices, and (2) 3D composite scaffolds for tissue engineering including injectable hydrogels for drug delivery, and development of bio-ink.

Project 1. Antimicrobial biomaterials

Nowadays, there is a significant need for effective anti-inflammatory biomaterials to prevent biomedical implants and device associated infections. Surface-centralized infections are also implicated in food contamination, escalation of foodborne infection, and biofouling of materials. In recent years, new nanotechnology-based antimicrobials have been designed to kill planktonic and antibiotic-resistant bacteria, as nanoparticles are not affected by most of the antibiotic resistance mechanisms. However, additional research needed to combat biofilm-infections, because biofilm-bacteria are more resistant to antimicrobial agents. Among the wide selection of nanomaterials, dendritic mesoporous silica nanoparticles (DMSNs) have great potential in the treatment of microbial infection by surface functionalization with antimicrobials and conjugation with specific targeting molecules. MSNs are extremely suitable for carrying antibiotic aminoglycosides and poorly soluble drugs because of its high surface area, large pore volume, and easy surface modification. The SiO_2 nanoparticles can also be served as nano reservoirs for adsorption of metallic ions such as copper, iron, zinc, silver, and gold ions, for antimicrobial effect against drug-resistant strains, **Figure 1**.

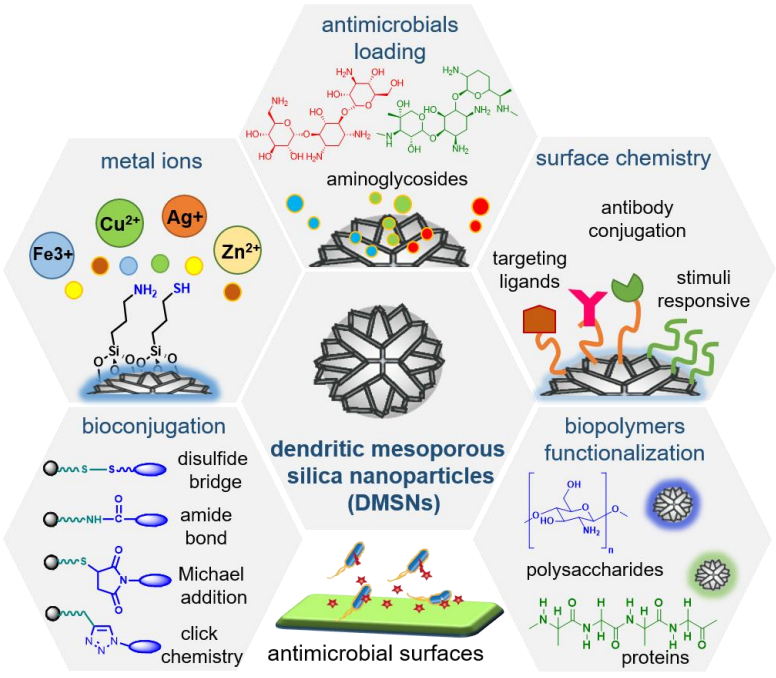

Figure 1. Diagram summarizing the key surface functionalization techniques for DMSN in the preparation of efficient antimicrobial materials.

Project 2. Development of novel bioactive, 3D sponge-type scaffolds for tissue engineering

Tissue engineering is an emerging field due to e.g., the increasing requirement of implants in case of organ failures. It aims to regenerate biological tissues for patients having medical conditions that involve complete or partial tissue loss or dysfunction. Biomaterials have shown supremacy in tissue repair and regeneration as they have demonstrated comparatively high compatibility with the native extracellular matrix (ECM). Here, I propose to develop biomimetic and drug-eluting biomaterial based scaffolds and bio-inks to fulfil the current clinical need of multifunctional scaffolds to repair large tissue defects in tissue engineering. Biomaterials of my research interest are polysaccharides (chitosan, hyaluronic acid, and alginate) and proteins (silk fibroin, gelatin, and collagen), **Figure 2.**

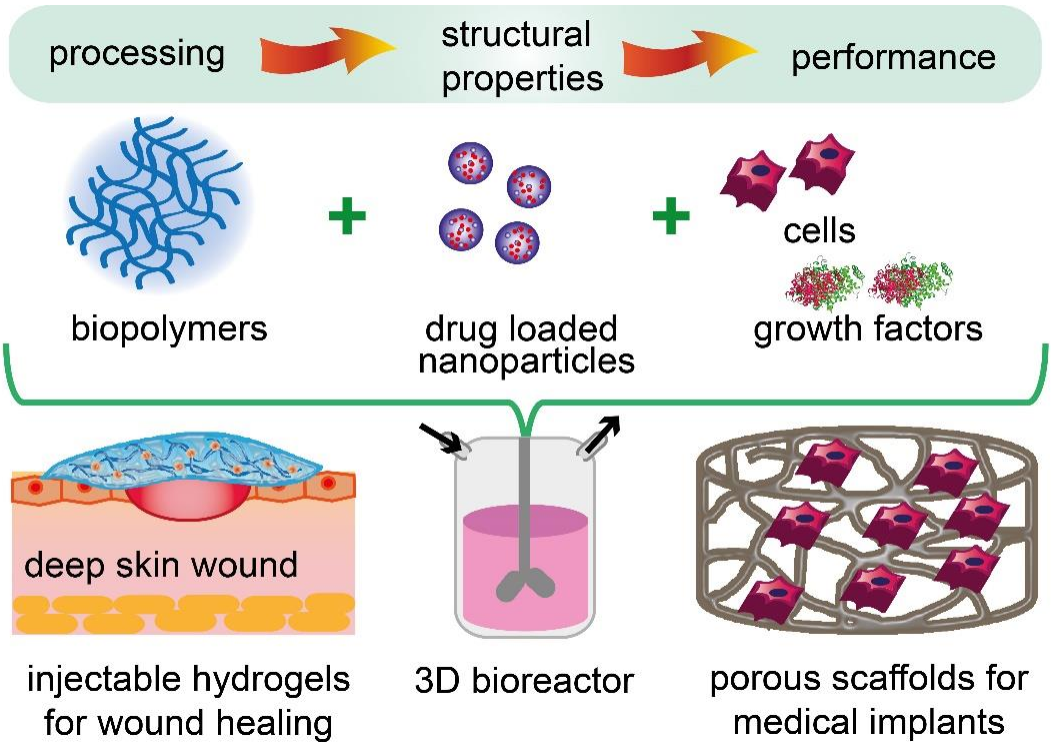

Figure 2. Different processing parameters influence the structural properties of the composite biomaterial and their performance in the medical field. Both synthetic and naturally derived biopolymers embedded with nanomaterials, growth factors and cells can be used to produce composite hydrogels, scaffolds, and evaluation of their properties using 3D bioreactor for biomedical applications.

Grants

1. Bioactive, Three Dimensional Sponge-Type Silk-Silica Composite Scaffolds for Bone Tissue Engineering, **Principal Investigator**, funded by Science and Engineering Research Board (SERB) funded project (NPDF, No. **PDF/ 2019/002997**) at IISc Bangalore, Amount-Indian Rs. 236800.00, duration (2020-2022). Status: Completed.

Fellowships and Awards

- Best micrograph contest award (SEM category) at the Annual Student Symposium of the Department of Materials Engineering, IISc, India, April 2022.
- Top Five of MaterialNext Grand Finale 2021 on "Novel Coatings" organized by Tata- Steel, India.
- SERB National Post-Doctoral fellowship, Government of India, 2020-2022.
- Chancen Gleichheit Postdoctoral Scholarship, Bavarian State Government, 2016-2017.
- Senior Research Fellowship awarded by Council of Scientific and Industrial Research (CSIR), India, 2012– 2015.
- GATE (Graduate Aptitude Test in Engineering, Subject: Chemistry), Ministry of Human Resource Development, Govt. of India, April 2011.
- Visiting Research Scholar under the supervision of Prof. Dr. David Diaz Diaz at Regensburg University, INDIGO Programme, Germany, April-May 2014.
- Best poster presentation award in Physical and Material Chemistry division at "National Science Day" organized by CSIR-National Chemical Laboratory, Pune, 2014.
- Best poster presentation award in Chemical Engineering and Process Development division at "National Science Day" organized by CSIR-National Chemical Laboratory, Pune, 2014.

Oral Presentation

1. **S. Kumari**, P. Mondal, K. Chatterjee "3D Bioprinting of Photo-cross linkable Kappa-Carrageenan Hydrogels to Fabricate Cell-loaded Tissue Scaffolds" Annual Student Symposium of the Department of Materials Engineering, IISc, India, April 2022.

2. **S. Kumari**, P. Mondal, K. Chatterjee "Development of Photocrosslinkable Kappa-Carrageenan Bioink to Fabricate Cell-Laden Scaffolds with High Cytocompatibility" ACS Spring 2022, March 20-24, 2022, virtually.

3. **S. Kumari**, P. Mondal, K. Chatterjee "3D Bioprinting of Photo-cross linkable Kappa-Carrageenan Hydrogels for Tissue Engineering Applications" International conference on Polymeric Materials in Medicine (ICPMM), India, Feb 2022, virtually.

4. **S. Kumari**, P. Mondal, K. Chatterjee "3D Bioprinting of Photo-cross linkable Kappa-Carrageenan Hydrogels for Tissue Engineering Applications" International conference on Polymeric Materials in Medicine (ICPMM), India, Feb 2022, virtually.

5. **S. Kumari**, G. Lang, E. Desimone, S. Lücker, T. Scheibel "Recombinant spider silk-based hydrogels as a prolonged delivery system for therapeutic biologicals" 4th Euro Bio-inspired Materials, Potsdam, Germany, Feb 2018.

Poster Presentations and Conferences Attended

1. **S. Kumari**, P. Mondal, K. Chatterjee, "3D Bioprinting of Photo-crosslinkable Kappa-Carrageenan Hydrogels to Fabricate Bio constructs" poster presentation in the Biomaterial-Based Therapeutics, Engineering and Medicine (BIOTEM 2021), participated virtually from 17-20 Dec 2021.

2. **S. Kumari,** B. B. Dhar, C. Panda, A. Meena, S. Sen Gupta, "Development of Peroxidase Mimic Fe (III) complexes anchored on MSNPs" poster presentation in the "International Symposium on Bioorganic Chemistry (ISBOC-10)" held at Indian Institute of Science Education and Research, Pune, India, from 11-15th Jan 2015.

3. **S. Kumari,** B. B. Dhar, C. Panda, A. Meena, S. Sen Gupta, "Development of Peroxidase Mimic Fe (III) complexes anchored on (Mesoporous Silica NPs)" poster presentation in the "Indo-German Conference on Bioinspired Chemistry (IGCBIC-2014)" held at Indian Institute of Science, Bangalore, India from 10-12th Sept 2014.

4. **S. Kumari,** A. Kulkarni, G. Kumaraswamy, S. Sen Gupta, "Large Centimeter-Sized Macroporous Ferritin Gel as Versatile Nanoreactors" poster presentation in the "16th CRSI National Symposium in Chemistry (NSC-16)" held at Indian Institute of Technology Bombay, Powai, Mumbai, India from 7-9th Feb 2014.

5. **S. Kumari,** G. Kumaraswamy, S. Sen Gupta, "Self Standing Three-Dimensional Macroporous Scaffold using Ferritin and its Application as a Catalyst" poster presentation in the "Third International Conference on Multifunctional, Hybrid and Nanomaterials" held in Sorrento, Naples, Italy from 3-7th Mar 2013.

6. **S. Kumari,** B. Malvi, S. Sen Gupta, "A Facile Route for Functionalization of Mesoporous Materials using Thiol-Ene Click Chemistry" poster presentation in the "RSC-WEST INDIA SECTION Ph.D. STUDENTS SYMPOSIUM" held at Goa University, Goa, India from 3-4th Sept 2010.

Symposia Attended

1. Bayreuth Polymer Symposium, University of Bayreuth, Germany, 2015 and 2017.

2. 3rd Erlangen Symposium on Biomaterials: "Challenges for the 21st Century" held at Erlangen, Germany on 28th Nov 2016.

Patent

1. Sayam Sen Gupta, **Sushma Kumari**, Chakadola Panda, U. S. Patent 20170016854A1, "Method for in-gel visual detection of bioanalytes" January 19, 2017.

Published Manuscripts

1. **S. Kumari**, P. Mondal, K. Chatterjee,* Digital light processing-based 3D bioprinting of κ-carrageenan hydrogels for engineering cell-loaded tissue scaffolds. *Carbohydrate Polymers* 290, 119508 (**2022**). IF: 9.38

2. **S. Kumari**, K. Chatterjee,* Biomaterials-based formulations and surfaces to combat viral infectious diseases. *APL bioengineering* 5, 011503 (**2021**).

3. **S. Kumari**, G. Lang, E. DeSimone, C. Spengler, S. Lücker, M. Hudel, K. Jacobs, N. Krämer, T. Scheibel,* Engineered spider silk-based 2D and 3D materials prevent microbial infestation. *Materials Today* 41, 21-33 (**2020**). IF: 31.04

4. **S. Kumari**, G. Lang, E. DeSimone, C. Spengler, S. Lücker, M. Hudel, K. Jacobs, N. Krämer, T. Scheibel,* Data for microbe resistant engineered recombinant spider silk protein based 2D and 3D materials. *Data in Brief* 32, 106305 (**2020**). IF: 1.334

5. **S. Kumari**, H. Bargel, T. Scheibel,* Recombinant spider silk–silica hybrid scaffolds with drug-releasing properties for tissue engineering applications. *Macromolecular Rapid Communications* 41, 1900426 (**2020**). IF: 5.734

6. T. Huang, **S. Kumari**, H. Herold, H. Bargel, T. Aigner, D. E. Heath, N. M. O'Brien-Simpson, A. J. O' Connor,* T. Scheibel,* Enhanced antibacterial activity of se nanoparticles upon coating with recombinant spider silk protein eADF4 (κ16). *International Journal of Nanomedicine* 15, 4275 (**2020**). IF: 4.471

7. **S. Kumari**, H. Bargel, M. U. Anby, D. Lafargue, T. Scheibel,* Recombinant spider silk hydrogels for sustained release of biologicals. *ACS Biomaterials Science & Engineering* 4, 1750-1759 (**2018**). IF: 5.13

8. **S. Kumari**, M. Häring, S. S. Gupta, D. Díaz Díaz,* Catalytic Macroporous Biohydrogels Made of Ferritin-Encapsulated Gold Nanoparticles. *ChemPlusChem* 82, 225-232 (**2017**). IF: 2.863

9. **S. Kumari**, C. Panda, S. Mazumdar, S. S. Gupta,* A molecular Fe-complex as a catalyst probe for in-gel visual detection of proteins via signal amplification. *Chemical Communications* 51, 15257-15260 (**2015**). IF: 6.22

10. S. Kandambeth, V. Venkatesh, D.B. Shinde, **S. Kumari**, A. Halder, S. Verma, R. Banerjee,* Self-templated chemically stable hollow spherical covalent organic framework. *Nature communications* 6, 1-10 (**2015**). IF: 14.92

11. R. Rajamanickam, **S. Kumari**, D. Kumar, S. Ghosh, J.C. Kim, G. Tae, S. Sen Gupta,* G. Kumaraswamy,* Soft colloidal scaffolds capable of elastic recovery after large compressive strains. *Chemistry of Materials* 26, 5161-5168 (**2014**). IF: 9.811

12. **S. Kumari**, B. B. Dhar, C. Panda, A. Meena, S. Sen Gupta,* Fe-TAML encapsulated inside mesoporous silica nanoparticles as peroxidase mimic: femtomolar protein detection. *ACS applied materials & interfaces* 6, 13866-13873 (**2014**). IF: 9.229

13. **S. Kumari**, A. Kulkarni, G. Kumaraswamy,* S. Sen Gupta,* Large Centimeter-Sized Macroporous Ferritin Gels as Versatile Nanoreactors. *Chemistry of Materials* 25, 4813-4819 (**2013**). IF: 9.811

14. A.K. Ganai, **S. Kumari**, K.P. Sharma, C. Panda, G. Kumaraswamy,* S. Sen Gupta,* Synthesis of functional hybrid silica scaffolds with controllable hierarchical porosity by dynamic templating. *Chemical Communications* 48, 5292-5294 (**2012**). IF: 6.22

15. **S. Kumari**, B. Malvi, A. K. Ganai, V. K. Pillai, S. Sen Gupta,* Functionalization of SBA-15 mesoporous materials using “thiol–ene click” Michael addition reaction. *The Journal of Physical Chemistry C* 115, 17774-17781 (**2011**). IF: 4.126

Popular Articles

1. **S. Kumari**, K. Chatterjee, S. Asthana, The development of biomaterial-based vaccine platforms against viruses, *Drug Target Review*, **2021**, Issue 1: 6-8