Programmable nests for cells

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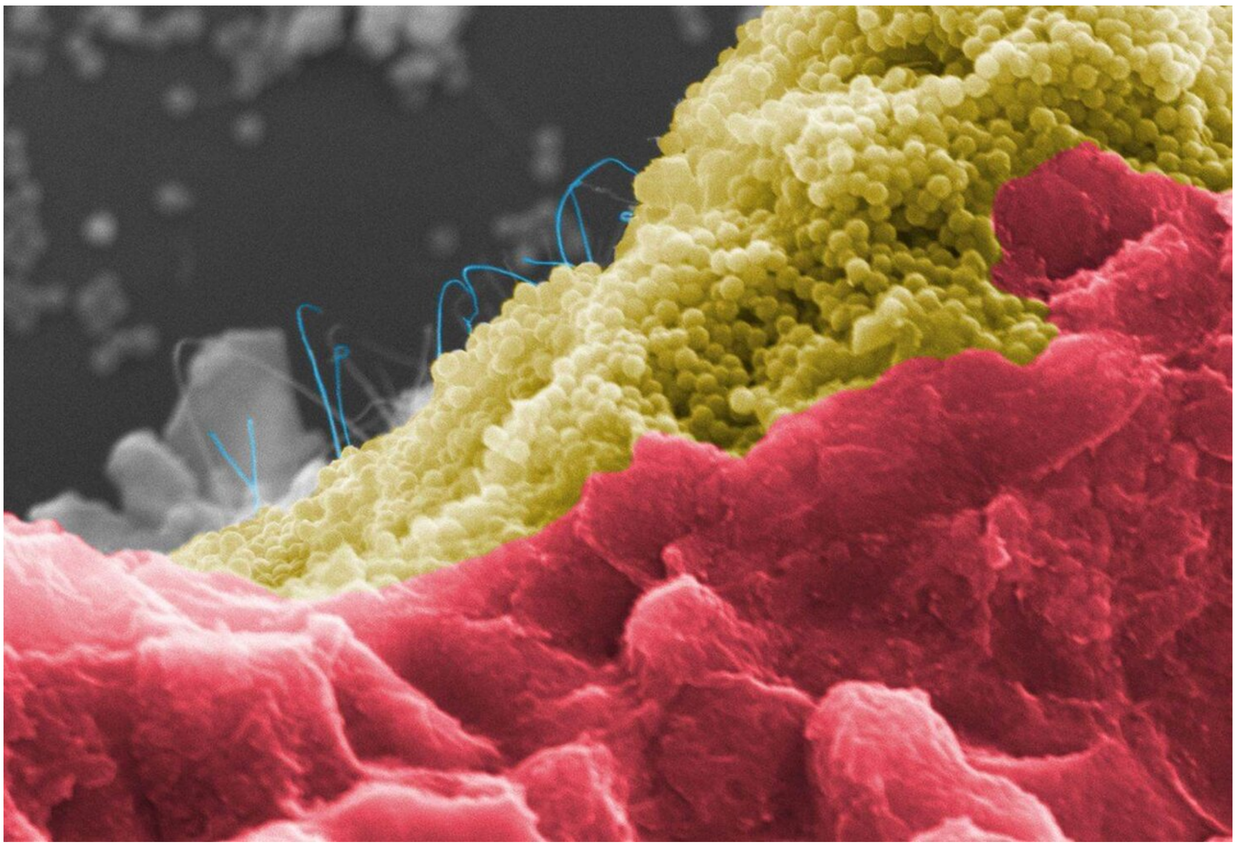

Bacteria cells (red) on a programmable composite of silica nanoparticles (yellow) and carbon nanotubes (blue). Credit: Niemeyer-Lab, KIT

Using DNA, small silica particles, and carbon nanotubes, researchers of Karlsruhe Institute of Technology (KIT) have developed novel programmable nanocomposites that can be tailored to various applications and programmed to degrade quickly and gently. For medical applications, they can create environments in which human stem cells can settle down and develop further. Additionally, they are suited for the setup of biohybrid systems to produce power, for instance. The results are presented in *Nature Communications* and on the bioRxiv platform.

Stem cells are cultivated for fundamental research and development of effective therapies against severe diseases, i.e., to replace damaged tissue. However, stem cells will only form healthy tissue in an adequate environment. For the formation of three-dimensional tissue structures, materials are needed that support cell functions with perfect elasticity. New programmable materials suited for use as substrates in biomedical applications have now been developed by the group of Professor Christof M. Niemeyer of the Institute for Biological Interfaces, together with colleagues from the Institute of Mechanical Process Engineering and Mechanics, the Zoological Institute, and the Institute of Functional Interfaces of KIT. These materials can be used among others to create environments in which human stem cells can settle down and further develop.

As reported by the researchers in *Nature Communications*, the new materials consist of DNA, small silica particles, and carbon nanotubes. "These composites are produced by a biochemical reaction and their properties can be adjusted by varying the amounts of the individual constituents," Christof M. Niemeyer explains. In addition, the nanocomposites can be programmed for rapid and gentle degradation and release of the cells grown inside, which can then be used for further experiments.

New Materials for Biohybrid Systems

According to another publication by the team on the bioRxiv bioscience platform, the new nanocomposites can also be used for construction of programmable biohybrid systems. "Use of living microorganisms integrated within electrochemical devices is an expanding field of research," says Professor Johannes Gescher from the Institute for Applied Biosciences (IAB) of KIT, who was involved in this study. "It is possible to produce microbial fuel cells, microbial biosensors, or microbial bioreactors in this way."

The biohybrid system constructed by KIT researchers contains the bacterium Shewanella oneidensis. It is exoelectrogenic, which means that when the organic substance is degraded under the lack of oxygen, an electric current is produced. When Shewanella oneidensis is cultivated in the nanocomposites developed by KIT, it populates the matrix of the composite, whereas the non-exoelectrogenic Escherichia coli bacterium remains on its surface. The Shewanella-containing composite remains stable for several days. Future work will be aimed at opening up new bioengineering applications of the new materials.

More information: Yong Hu et al. Carbon-nanotube reinforcement of DNA-silica nanocomposites yields programmable and cell-instructive biocoatings, *Nature Communications* (2019). DOI: 10.1038/s41467-019-13381-1

Yong Hu et al. Cultivation of Exoelectrogenic Bacteria in Conductive DNA Nanocomposite Hydrogels Yields a Programmable Biohybrid Materials System, (2019). DOI: 10.1101/864967

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