Biomedical Applications of Synthetic Materials

Advances in biomedical applications and bioscience research require the development of new synthetic materials with desirable structure, chemistry, and properties. Notable recent examples include the development of thin and flexible electronic circuits for interfacing and monitoring the properties of soft tissue[1] and shape-responsive surgical stents[2]. This work is highly interdisciplinary requiring the integration of precision chemical synthesis techniques, engineering processing and control (ultimately necessary for FDA compliance), physical property characterization, and interfacing synthetic materials with living systems.

Rice has significant efforts in this area: The Pasquali group has developed methods for creating conductive carbon nanotube fibers that can be used as soft interfaces with the electrical conduction of the heart and brain. In collaboration with the Jacot group, this work has enhanced electrical connections in scaffolds for cardiomyocyte growth[3], while superior performance as brain electrodes has been achieved in collaboration with the Kemere group[4]. Also in collaborations with the Jacot group, the Verduzco group has studied the use of shape-responsive, biocompatible polymer networks for dynamic cell culture[5]. The Mikos group has demonstrated biodegradable polymer hydrogel technologies for bone and cartilage tissue engineering. A number of groups including the Segatori, Drezek, and Alvarez groups have explored the interactions and potential applications of nanoparticles with living systems.

The broad area of biocompatible and biologically active materials provides a number of opportunities for development of new educational programs. Students are able to work on fundamental topics related to materials synthesis and cellular bioengineering and more applied topics related to development and testing of devices. This effort also leverages two traditional strengths of Rice (bio and nano-materials) while introducing new concepts on tight control on synthesis and molecular structure and their function in biological environments. This area lends itself to integration with new entrepreneurial initiatives on campus, such as the NSF iCorps program which promotes the translation of federally funded research to real-world products and applications.

An initial investment focused on student-support for collaborative research projects and instrumentation needs could promote collaboration between faculty in different research groups and the development of externally funded projects.

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