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Interdisciplinary collaboration between engineering, mathematics and science

SEMS Research Highlights

Understanding Brain Injury and Disease through Biomechanics and Biohybrid Microdevices

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This newsletter presents the research conducted within the School of Engineering, Mathematics and Science (SEMS) at Robert Morris University (RMU). It covers various relevant topics including: interdisciplinary efforts, successful research grants, student research, posters and papers, journal publications, presentations at national and international conferences, contribution to professional societies, STEM educational research, industrial consulting collaborations and applied research.

Traumatic brain injury (TBI) is a debilitating injury that is caused by mechanical loads to the head. One of the main pathological features of TBI is diffuse axonal injury, which is widespread damage to the neural axons in the brain. These neural axons serve as information highways. When these pathways of communication are damaged, cognitive and physical impairments can result.

Computational models that incorporate the biomechanics of injury can provide useful insight into the mechanisms of TBI. By accurately representing the orientation of the neural axons in the brain and predicting the amount of strain in these axons for a given loading condition to the head, better predications of the location and extent of injury can be made (see Fig. 1). These models can be applied to develop better protective equipment for athletes, to establish return-to-play guidelines for concussive injury, and to guide the design of safer vehicles.

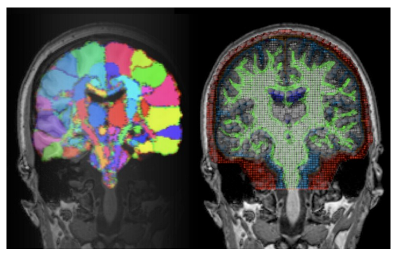

Figure 1. Functional brain regions (left) are correlated to a computational finite element head model (right) to predict functional outcomes resulting from head impacts.

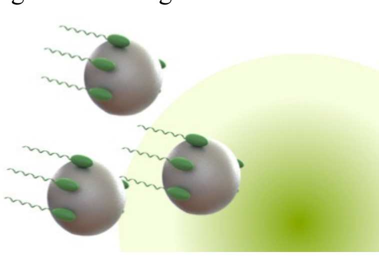

Figure 2. Schematic of bacteria-propelled drug delivery carriers.

Biohybrid microdevices integrate live biological cells with synthetic materials to perform useful tasks at the micro-scale. These biohybrid microdevices are being investigated as potential targeted drug delivery carriers that can be applied in the diagnosis and treatment of disease.

An example of a biohybrid microdevice is the integration of motile bacterial cells with a drug delivery carrier (see Fig. 2). The bacterial cells provide a propulsive force, enabling the carrier to "swim" through fluid environments. The microdevice can be guided to a targeted site by utilizing the sensing capabilities of the cells or through external stimuli such as magnetic or electric fields. These novel biohybrid microdevices offer a new approach for targeted drug delivery.

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