CLEMSON UNIVERSITY

C3B

Center for Bioelectronics, Biosensors and Biochips

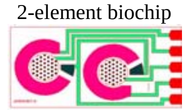
Platform Projects

C3B Research: Focused on the confluence of molecular biomedicine, informatics and engineering

The 21st century portends advances in genomics, nanobiotechnology, biomaterials and biointerfaces, and bioinformatics that together promise to revolutionize the conduct and fruits of biotechnology research. The National Institute of Health has recognized that traditional research methods should be supplemented with an interdisciplinary research approach, *"…one that broadens the scope of investigation into biomedical problems, yields fresh and possibly unexpected insights, and may even give birth to new hybrid disciplines that are more analytically sophisticated."* By focusing on the confluence of advances in molecular biology, biomedicine, informatics, and engineering, C3B platform projects spawn multidisciplinary, collaborative research opportunities that seek to improve human health and quality of life.

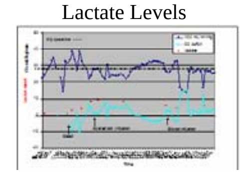
Implantable biosensors for monitoring during trauma

2-element biochip



C3B researchers are working pertinaciously to develop an implantable biosensor for monitoring lactate and glucose levels in the tissues of trauma victims. Funded by the Department of Defense, the goal of this platform project is to develop a temporary implantable biosensor with wireless communication capabilities. Packaging a dual sensing element biochip into the biosensor poses significant engineering challenges. Our researchers are investigating the amperometric response of the biochip to glucose and lactate, the biocompatibility of hydrogels used for coating the biochip, and the biochip's long and short term performance in laboratory animals.

Lactate Levels



Research breakthroughs in this platform project will have prodigious contributions to mass triage scenarios such as battlefields and natural disaster sites by providing a means for medical personnel to make life saving decisions. The ability to monitor lactate and glucose levels with an implantable biosensor is also important for future applications in diabetes care, transplant organ health, intensive care and space exploration.

Cell-based neurotoxicity array biosensor

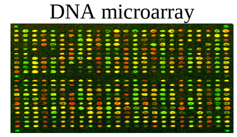
Cell-based neurotoxicity array biosensors increase testing throughput by providing multiple wells integrated with biosensing elements. By using an eight-well array system, a scientist can test for the effects of a toxin on eight differentiated cell cultures or eight toxins on a given cell culture. This platform project also offers researchers an alternative to using live animals in their investigations by providing differentiated cell cultures as proxies for living tissues.

8-Well Array

Experiments have been conducted on growing and differentiating cell cultures in the arrays, measuring the impedance signatures of various drugs on the cells, and interpreting the results using an artificial neural network. Cell-based sensing provides more reliable information regarding the efficacy of chemicals on cells over time. One significant application of this platform project is the detection of toxins associated with biochemical threats.

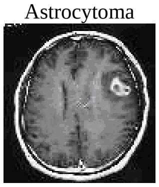
DNA biochips for brain tumor cancer diagnostic and prognostics

DNA microarray



This platform project applies DNA microarray technology to the search for improved diagnosis and treatment of brain tumor patients. DNA microarrays have enabled researchers to study expression profiles of cell populations in far greater detail, with upwards of 30,000 DNA hybridization samples on a standard microscope slide. Since cancer cells have different expression profiles than normal surrounding tissue, this application of DNA microarray is well suited for identifying a targeted suite of genes associated with brain tumors.

Astrocytoma

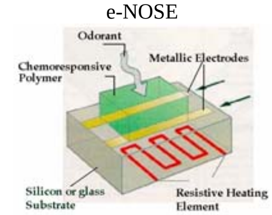


Astrocytomas kill about 17,000 brain cancer victims each year in the United States. Current pathological methods for classifying stages of these tumors are subjective and prone to misdiagnosis. Experiments are being conducted using DNA microarrays to identify a targeted suite of genes associated with astrocytomas that will be used in the Brain Tumor Biochip. Development of a DNA biochip that can delineate the World Health Organization defined classes of astrocytomas for improved diagnostics will lead to improved therapeutic efficacy. Other DNA microarray experiments will be conducted to examine the gene expressions of ovarian and breast cancer tumors. DNA biochips have the potential to revolutionize the way cancer tumors are classified and staged, and to pave the way for targeted gene therapy treatments.

Electronic NOSE for trauma monitoring

Of the five human senses, the sense of smell is least understood by scientists and engineers. Odors can be simply described as chemicals dissolved in the air. The scientific challenge is to develop a sensing system capable of detecting trace amounts of chemicals that are associated with a particular class of odors. The electronic NOSE (Natural Olfactory Sensor Emulator™) platform project investigates the use of a sensing system along with an artificial neural network to distinguish specific chemicals from certain odors. An exciting application of the e-NOSE is to determine the physiological status of shock and trauma patients by monitoring their breath for volatile organic compounds.

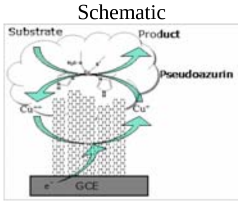
e-NOSE



Experiments are being conducted on the e-NOSE to improve sensor performance through design and material selection, characterize the sensing of various compounds, and develop a neural network that can identify the presence of specific chemicals by analyzing the electrical signals from the sensor array. Future research breakthroughs in the e-NOSE platform can have important applications in environmental monitoring and homeland security.

Sub-cellular monitoring using nanobiosensors and nanobeacons

Schematic



Advances in nanotechnology have yielded materials with engineering properties that are of interest to biosensors researchers. Incorporating nanoscale materials into biosensors and bioprobes allows researchers to directly monitor and measure their samples at the sub-cellular level. C3B researchers are investigating the use of carbon nanotubes in a nanobiosensor design with the goal of directly measuring electrochemical reactions without the use of reagents. Eliminating the need for reagents such as oxygen will greatly improve the performance of in vivo nanobiosensors and nanobeacons.

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