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13. ABSTRACT *(Maximum 200 words)*

An integrated workstation for studying cellular mechanics has been installed for the purpose of educating students and conducting research on how information is mechanically processed in living cells. The integrated workstation consists of manipulator tools that can be used to probe living cells with mechanical force while they are in the view of a microscope. The instrumentation is expected to enhance ONR funded research on cell-based biosensors by helping to establish a scientific basis for observations that have been made of pronounced toxicological perturbations of the mechanical transport of information in cells. The instrumentation will also serve as a focal point for improving the capabilities of scientists and engineers at Oregon State University to conduct defense-oriented microdevice research that is inspired by the very small machinery of living cells.

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FINAL REPORT

GRANT #: N0O014-98-1-0315

PRINCIPAL INVESTIGATOR: Philip N. McFadden

INSTITUTION: Oregon State University

GRANT TITLE: Instrumentation for the Center for Cellular Mechanics

AWARD PERIOD: 1 March 1998 - 1 June 1999

OBJECTIVE: To design and install an integrated workstation for studying cellular mechanics.

APPROACH: The central philosophy behind the design of the workstation is to maximize its versatility and adaptability for scientific experiments related to cell-based sensors. Versatility and adaptability are built into the workstation by the use of interchangeable components, upgradeable hardware and software, and an overall modular design that permits reconfiguration for the experiment at hand. Research themes are focused on understanding the movements and organization of those intracellular components that are in the size-realm requiring nanonewtons of mechanical force to undergo structural change.

ACCOMPLISHMENTS: The first research capability which has now been achieved is that of optically monitoring the internal dynamics of living cells while applying to them an external force driven by a micromanipulator. A second achievement has been the specialized capability of recording hyperspectral (multi-wavelength) structural information from cells during their manipulation. A third achievement has been the elucidation by high-resolution optics of the behavior of cellular components that is the biological basis of the "SOS Cytosensor System", a DARPA-supported project.

The first of the above achievements has been demonstrated by an AASERT graduate student researcher who is using the instrumentation to microinject into living biosensor cells a gene construct designed to test the hypothesis that protein kinases (key intracellular information enzymes) are mechanically shuttled to varying locales of these cells in conjunction with their biosensor activities. The second achievement has been demonstrated by a second AASERT graduate student researcher who is designing software algorithms to convert hyperspectral data into statistical descriptions of the multi-wavelength information conveyed by living biosensor cells during their exposure to toxins. The third achievement is now providing scientific specifications that will be

employed to optimize engineering designs of biosensor devices for defense-related toxicity testing.

CONCLUSIONS: The emerging picture supported by this instrument-enhanced research is that mechanical transport is fundamental to the description of information dispersal in living biosensor cells. By this view, packets of information conveyed by nanonewton forces, provide for highly localized responses to external toxic perturbations. Cell-based biosensors can use this principle to advantage.

SIGNIFICANCE: The multidisciplinary environment fostered by DURIP instrumentation has focused faculty- and student-interests around research themes that will advance both the science of cell-based biosensors and the general research field of biological control by minutely sized biomechanical elements.

PATENT INFORMATION: A patent application is in progress.

AWARD INFORMATION: None

PUBLICATIONS AND ABSTRACTS:

1. McFadden, P. N. (1999) The SOS Cytosensor System (in preparation).

2. Sellers, D. L. and McFadden, P. N. (1999) Shockwaves and sharp fronts in cytoplasm (in preparation).