Congressional briefing highlights organs-on-a-chip

By Paula Whitacre

A translucent device the size of a rubber eraser that contains not just the cells of a human organ, but also carries out that organ's functions — that's the exciting potential of biomimetic microsystems, new technology more descriptively called human "organs-on-a-chip" after its launch with the help of NIEHS.

Ingber explained how human "organs-on-a-chip" have the potential to transform many areas of biomedical research at a May 15 briefing on Capitol Hill. NIEHS funding provided critical early support for the concept. (Photo courtesy of Charles Votaw)

Donald Ingber, M.D., Ph.D., founding director of the Wyss Institute for Biologically Inspired Engineering at Harvard University, explained this breakthrough technology at a May 15 briefing on Capitol Hill, sponsored by the Congressional Biomedical Research Caucus (CBRC). "The chips change the paradigm," said Ingber. "We are engineering microchips, containing living cells that can reconstitute organ-level functions, for drug-screening, diagnostic, toxicologic, and therapeutic applications."

NIEHS provided funding to George Whitesides, Ph.D., Ingber, and other researchers that led to the creation of a lung-on-a-chip. It was the first of about a dozen devices now in various stages of development, including gut, kidney, and bone marrow. As Ingber explained, the NIEHS-supported Nano-Scale Tools for Use in Cell Biology *(http://tools.niehs.nih.gov/portfolio/index.cfm/portfolio/grantPubDetail/grant_number/R01ES016665)* project showed that, while nanoparticles in themselves do not seem to impact lung cells or tissues, the addition of breathing motion increases toxicity and inflammation — something the chip could detect, but could not be seen in standard cell culture studies.

"With this little rubber chip, we were not just mimicking function, but predicting it," said Ingber. Animal testing confirmed the finding, and the breakthrough was published in a 2010 paper *(http://www.sciencemag.org/content/328/5986/1662.abstract)* in the journal Science.

Leveraging biological principles

At the briefing, Ingber posed a problem that organs-on-a-chip can potentially solve. "More than $2 million is spent to test a single compound, and testing takes years to complete," he said. In addition, large numbers of animals are used, and there can be difficulty in extrapolating lab animal results to human. As an alternative, the chips can be used to construct human disease models and test drug effectiveness.

In 2011, the National Institutes of Health (NIH), the U.S. Food and Drug Administration (FDA), and the Defense Advanced Research Projects Agency (DARPA) announced a collaboration to develop cutting-edge technologies, such as these chips, to predict drug safety. "This is an unprecedented opportunity to speed development of effective therapies, while saving time and money," noted NIH Director Francis Collins, M.D., Ph.D., when President Obama announced the collaboration.

Ingber's lab received funding from DARPA, to develop automated instruments that will be able to construct the devices that postdocs now, painstakingly, put together. "We are just at the beginning, and it's not sophisticated," he said. "But the feasibility is there, and we're excited."

In addition, NIH and FDA are supporting development of the Heart-Lung Micromachine, to connect the lung-on-a-chip with a heart device developed in the lab of Kevin Kit Parker, Ph.D., also at the Wyss Institute. "Our long-term vision is a virtual human body on a chip," said Ingber.

As Ingber explained, the Wyss Institute was established in 2009 to leverage biological principles for developing new engineering innovations. Collaboration among pharmaceutical companies, government agencies, and academia is a hallmark, and, he said, measures of success include not only publications — at least one paper per month in the journals Science or Nature, for the last 52 months, with 14 core faculty — but also patents, startups, and other economic results.

Supporting biomedical research on the hill

The CBRC, a bipartisan group that broadens support and knowledge of basic and clinical biomedical research issues throughout Congress, sponsored Ingber's presentation, which was well attended by congressional staff members. The Coalition for Life Sciences, which serves as scientific advisor to the caucus, organized the event.

(Paula Whitacre is a contract writer with the NIEHS office in Bethesda, Md.)

The Environmental Factor is produced monthly by the National Institute of Environmental Health Sciences (NIEHS) *(http://www.niehs.nih.gov/)*, Office of Communications and Public Liaison. We welcome your comments and suggestions. *(bruskec@niehs.nih.gov)*

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