Title of proposed program: In vivo Sensors to Probe and Control Cells, Tissues, and Networks

Submitting Source: Strategic Planning Meeting

What is the major obstacle/challenge/opportunity that the Common Fund should address?
Accurate information about complex functionality in neurobiological and other systems requires many measurements across many independent sites and levels of integration. The means to acquire such data needs to be enhanced significantly, and the framing of large-scale data needs to follow principles of network logic. The opportunity is to develop systems-level models through self-consistency that allow the impact of changes at one level (e.g., motor control) to be seen through changes at a lower level (e.g., cells). For example, *in vivo* biosensors are rendered nonfunctional in the body due to the biological reaction at the material tissue interface, and standards for characterization do not exist to permit sharing/comparison of data among researchers. To make this happen, engineers/instrumentation specialists will need to understand the basic principles of biology because biologists typically do not build sensors. The overall program goal would be to enhance our understanding and control of material-tissue interfaces to allow sensors to exist and function in the body.

What would the goals of the program be?
This program could have multiple goals:

- Create platform interfaces that enable 2-way communication between biological and electronic systems for diagnostic, stimulation, and treatment purposes
- Pilot the use of in vivo sensors, analyzing foreign body response to implanted materials and modulating this response through surface texturing
- Develop and validate high-throughput methods for assessing differential elicitation of the foreign body response by different materials; develop methods to modulate the immune response to non-viral drug and gene delivery modules.

Why is a trans-NIH strategy needed to achieve these goals?
By addressing biosystems from an engineering control theory approach to work out basic logic in the normal state, impact in disease states is readily deduced or even predicted. This would have enormous application for basic and applied research conducted across the ICs.

What initiatives might form the strategic plan for this topic?

- Create platform-type interfaces that enable 2-way communication between biological and electronic systems for diagnostic, stimulation, and treatment purposes
    - Pilot a physical and electrical engineering approach to high-density measurements
    - Establish standardized analysis methods with community-accepted algorithms
- Pilot the use of in vivo sensors
    - Demonstration projects to be conducted in various tissues in animal models
    - Automate methods or crowd-source methods for self-consistency checks

If a Common Fund program on this topic achieved its objectives, what would be the impact?

Revolutionary developments in electronics and signal processing and nanofabrication would be translated to the biomedical field. Modern technical innovation in instrumentation and analysis would naturally follow.