

## 2<sup>nd</sup> Annual National Academies Keck *Futures Initiative* Conference

### *Designing Nanostructures at the Interface between Biomedical and Physical Systems*

Arnold & Mabel Beckman Center, Irvine, California

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#### **Build a System that will Detect Disease in vivo and Report Back Results**

##### **Focus Group Description**

##### **Background**

Human disease is currently assessed by several methods: blood tests, physiological monitoring (blood pressure, heart rate), imaging (MRI, Ultrasound), or laboratory analysis of tissue samples obtained by biopsy. However, disease processes occur at the molecular level inside cells and tissues distributed throughout the body and unfold at the 10 nm to 10  $\mu$ m length scale. Examples include neuron dysfunction in Alzheimer's, unregulated cell proliferation in cancer, or atherosclerosis in blood vessels. The body has natural surveillance mechanisms like immune cells that continuously circulate through the blood, lymph, and tissues, and detect foreign invaders, however technological analogs that could survey the body 'from the inside' to detect disease early are not available. In order to be useful, such a device or system would need to interface with physicians and patients to provide data that can be acted upon. In the laypress, this idea is often discussed in the context of the 1966 science fiction film, the *Fantastic Voyage*, where a surgical team was miniaturized and injected into the circulation of a dying man.

##### **The Problem**

- Consider how diseased tissue would be recognized. One way is to use the circulation to survey all the blood vessels of the body. There is emerging evidence that vessels of diseased tissues have distinct characteristics from others. What other ways might be worth considering? Keep in mind burgeoning efforts to identify molecular markers using genomic/proteomic technologies for many disease processes.
- Consider how detection of diseased tissue would be reported to the physician. One way is to transmit a signal with radio waves. Another is to image using signals that penetrate tissues (i.e. near infrared light). Another is to collect a sample that has a 'record' of what was encountered in the body. What other ways might be worth considering?
- Consider how such a device might help treat disease. One way is to deliver a drug. Another is to destroy tissue with heat. Another is to alter the diseased tissue via gene delivery. What other ways might be worth considering? How would one monitor the progress/success of such a therapy?
- Design a device that combines all these desired features: (1) recognize disease tissue (2) report back to physician (3) treat disease and (4) monitor therapy. What are the tradeoffs that one must consider? How might chemistry/engineering/biology at the micro- and nanoscale help address these limitations?

##### **Initial References**

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