

2nd 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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Design Principles of Living Systems
Focus Group Description

Background

Human functions are the most complicated systems. It is probably the greatest scientific and engineering challenge to duplicate some or all the basic human functions on a chip. The success of this work can be of tremendous societal and economic rewards. While the basic functions of a human organ are generally understood, the feasibility of fabricating nano or micro devices on a chip that supply the same biological, chemical, and electrical activities as those of a human organ has only been explored recently. Some of these examples include artificial noses, tongues, ears, retina, skin, etc. There are many more human functions that can be duplicated on a chip. Furthermore, with advancement of the nano science and engineering, the integration of several human functions on a chip seems to be feasible. In principle, a human chip can be prepared based on the same or completely different scientific principles from the biological reactions in the actual human organ. The following are examples of the human on a chip concept.

The Problem

- Identify basic human functions in the nano scale.
- Build a nano digestion system that converts organic materials into energy.
- Build a nano breath system that converts O₂ to CO₂ and, in the mean while, releases energy.
- Build a nano viewing system that detects images and transfers them into digital data.
- Build a nano smelling system that can simultaneous identify different chemicals in a low concentration, low volume gas sample.
- Build a nano listening system that can record and identify acoustic signals over a wide range of frequency.
- Build a nano sensing system that can simultaneously detect minor changes of temperature, pressure, humidity, and other environmental factors.
- Build a nano electromechanical or optomechanical system that can move with the input of a light, sound, temperature, etc.
- Build a chip that contains more than one of the above functions.

Initial References

- Freedman, David, *The Silicon Guinea Pig. Technology Review*, June 2004. **107** pp. 62-69.