

Androids in our future: Toward networked, intelligent bioelectronics

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Nanotechnology research has made great strides in biological sensing and therapeutics through controlled or targeted drug release or electrical stimulation. Today, however, the loop closure is reminiscent of needing to call a plumber if the thermometer in your house indicates the temperature is uncomfortable. Having humans in the feedback loop is a waste of time and money, and degrades the efficacy of treatment. Up to 30% of U.S. healthcare costs are attributable to long term patient monitoring, an ideal insertion point for networked, intelligent biosensors. Diabetics require tight control of blood glucose levels, which has been demonstrated to strongly correlate with health benefits.

Closed loop bioelectronics for

- diabetes - blood glucose monitoring and insulin delivery;
- epilepsy – integrated ekg monitoring and Vagus nerve stimulation; and
- macular degeneration – sensitization and stimulation of the retina

are the examples in this presentation used to illustrate the opportunities for intelligent, networked bioelectronics. Closed loop control of biological function, however, entails significant technical and social challenges.

Resolving the technical hurdles will involve skills outside of the microelectronics industry. For example, surface- and bio-chemistry are required for interface to and packaging within biological systems. Many biosensors and drug delivery circuits rely on gold metallization and MEMS processing for microfluidics, both of which are currently niche technologies. Trends in ultra low power, such as deep subthreshold signal processing and communications will need to be married with autonomous networking and energy scavenging.

Social issues involve issues of both regulation and indemnification, both of which are poised to significantly slow the acceptance of intelligent bioelectronics.

