



# Convergence: Semiconductor, Pharmaceutical and Medical Device Industries

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**SIA**  
SEMICONDUCTOR  
INDUSTRY  
ASSOCIATION

# Strong global trends in Healthcare



## Aging populations

- In ten years (2019), 32% more people in the US will be over 65 years than today. By 2025 1.2 billion people will be over 50 years old, twice as many as in 2006.



## Rising healthcare costs

- U.S. healthcare spending more than 18% of GDP, Europe not far behind
- Costs expected to grow from \$2.5 trillion in 2009 to \$4.5 trillion in 2019



## Remote and emerging markets

- China healthcare expenditure increased from 3.7% of GDP in 1995 to 5.6% in 2007
- India government proposed in 2008 to increase public expenditure on health care from 1% to 3% of GDP



## Personal healthcare

- 33% of medical semiconductor revenue in 2008 went into consumer medical devices

# Semiconductors in Healthcare Revolution

## Computing revolution



Computing transformed

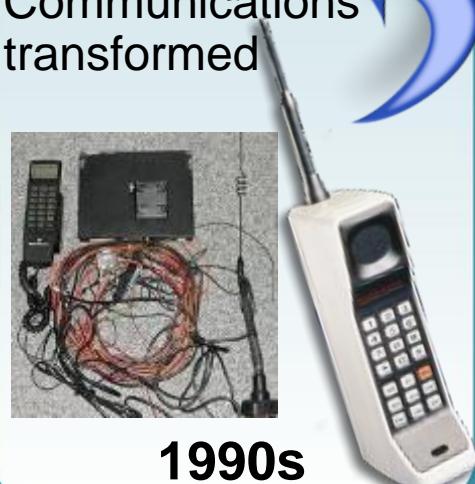


1980s

## Communications revolution



Communications transformed



1990s

## Healthcare revolution



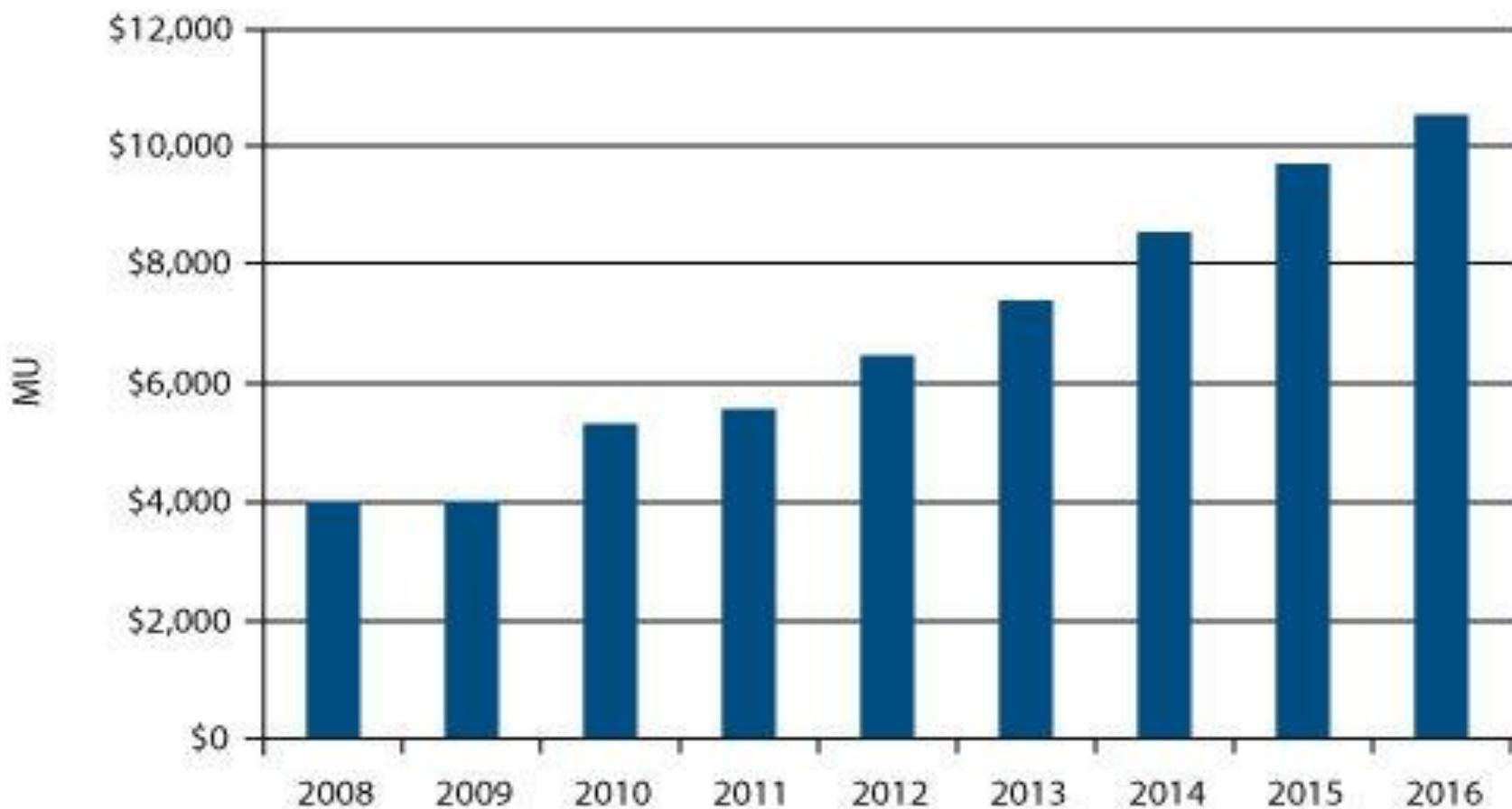
Healthcare transformed



2000 and beyond

# Medical Apps Boost Semiconductor Market

Worldwide medical semiconductor shipment forecast



Source: Databeans

# 100% monitoring in hospital settings



Images courtesy of Sotera wireless

# Bringing ultrasound to the *Point-of-Care*



Mt. Everest



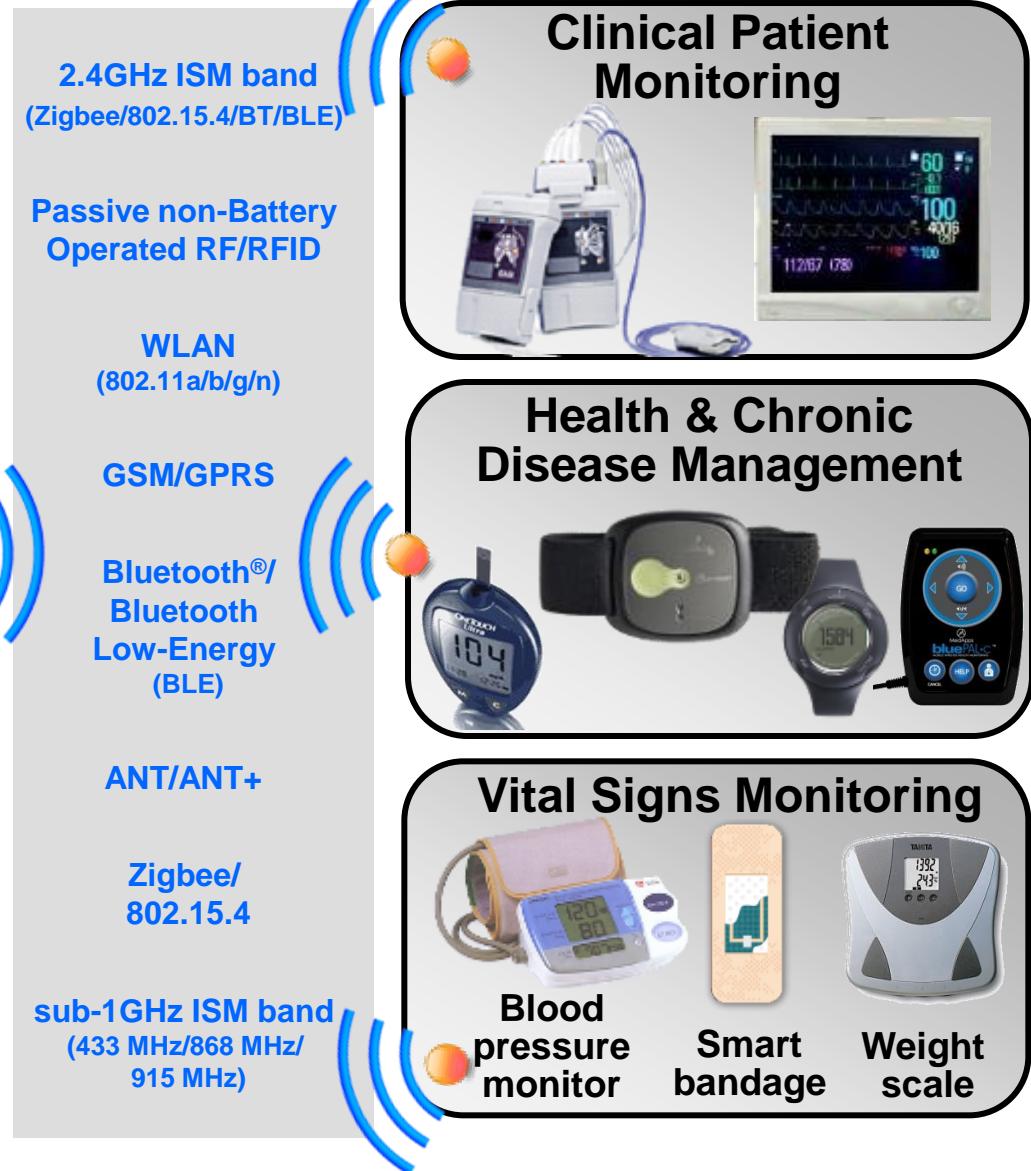
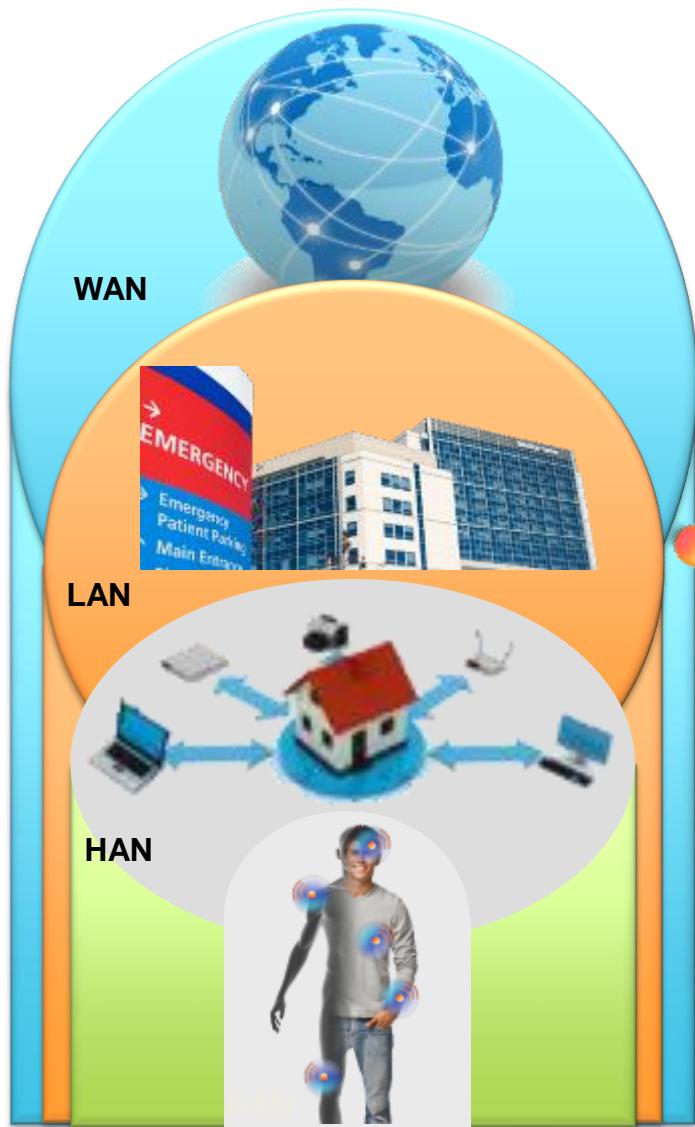
Tsunami



Military

Images courtesy of Sonosite

# Connected health, Health portfolio



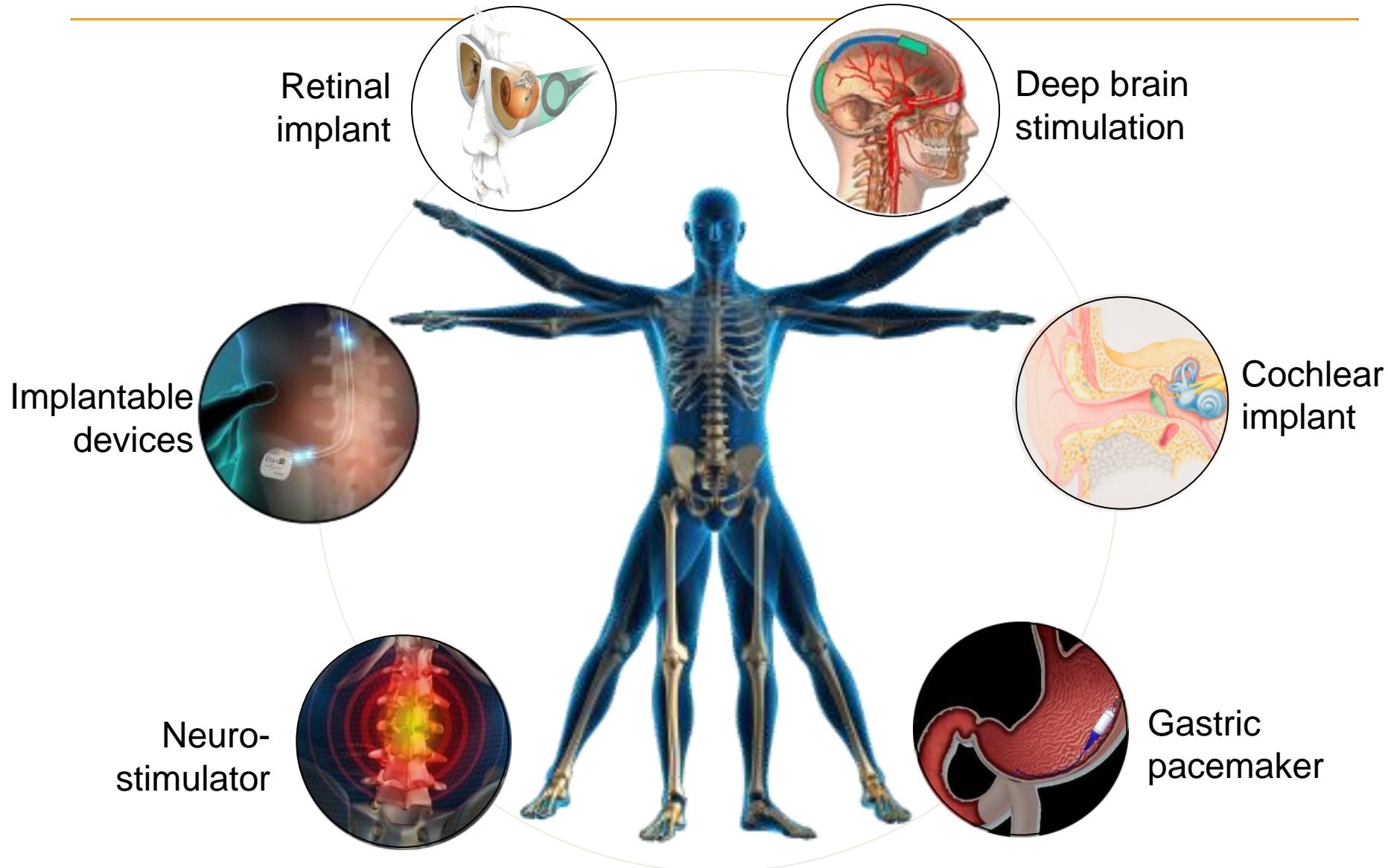
# Convenience



Non-invasive blood glucose  
monitoring using silicon  
bio-sensors

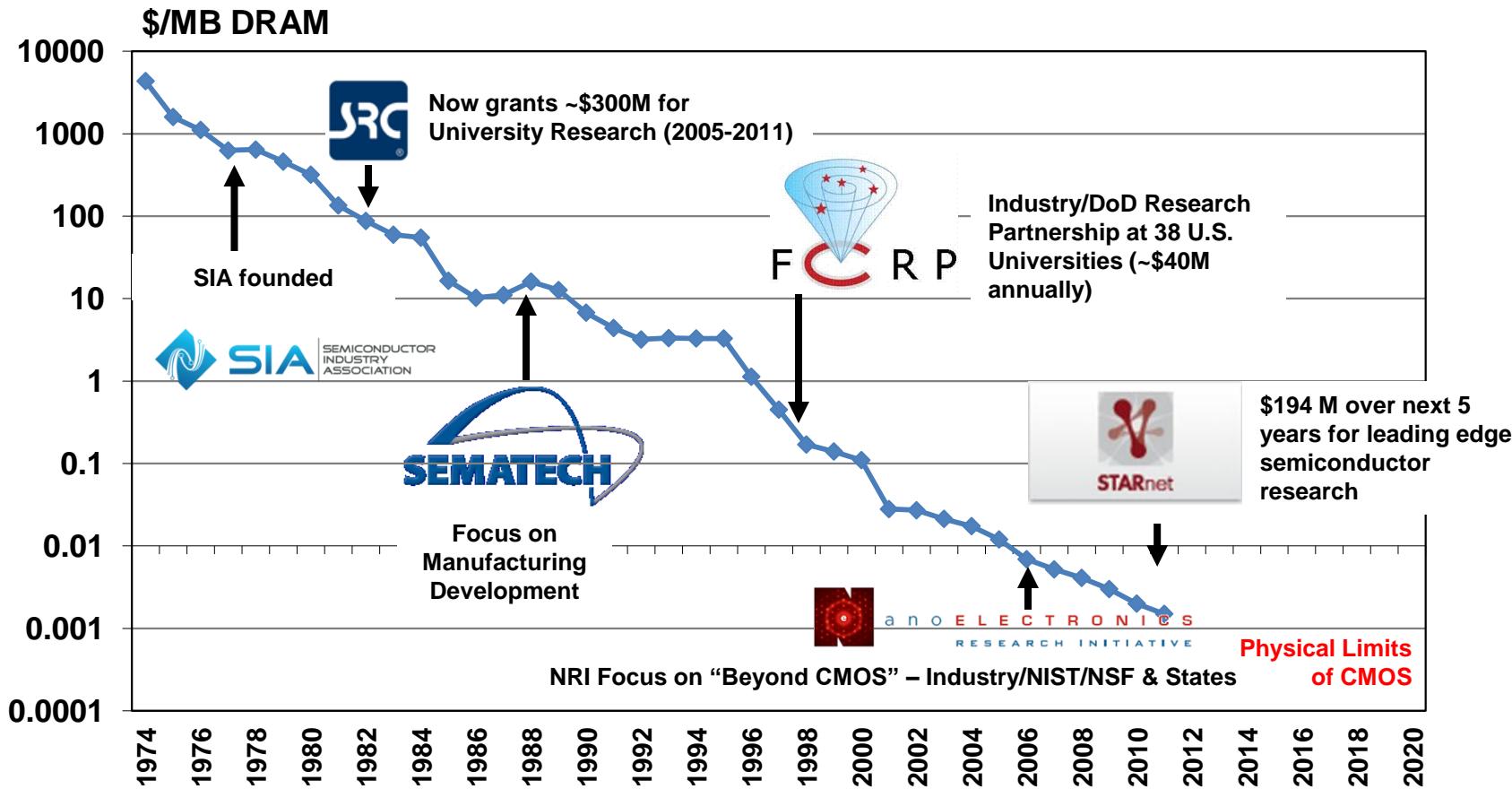
Images courtesy of Diagtronix

# Electronics inside the human body



# Decades of Industry Collaboration on Research

Industry consortia support for university basic research behind 10 fold drop in costs every six years



Source: DQ/Micron/WSTS

# Semiconductors and Synthetic Biology

## SemiSynbio Recent Breakthroughs

Foundation is being laid!

**STONY BROOK**  
1<sup>st</sup> chemical synthesis of poliovirus  
7.5 knt=15kbit

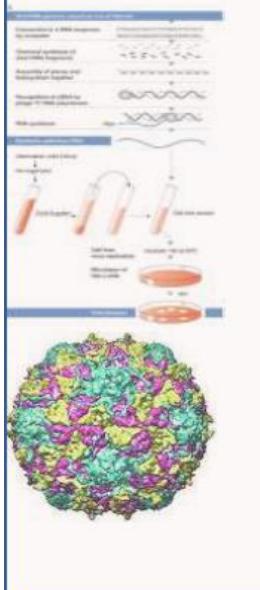


Diagram illustrating the 1<sup>st</sup> chemical synthesis of poliovirus, showing the capsid structure and the synthesis process.

**UNIVERSITY OF MICHIGAN**  
**UNIVERSITY OF HOUSTON**  
Chip-based high-throughput DNA synthesis

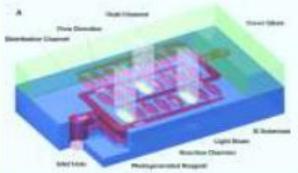


Diagram illustrating chip-based high-throughput DNA synthesis, showing the chip structure and synthesis process.

**CALIFORNIA INSTITUTE OF TECHNOLOGY**  
DNA Origami



Diagram illustrating DNA Origami, showing various complex shapes formed by DNA molecules.

**intel**  
EDA-BDA synergy manifested

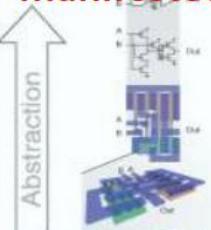


Diagram illustrating the synergy between EDA (Electronic Design Automation) and BDA (Bio Design Automation), showing a flow from abstraction to a 3D model of a DNA structure.

**IBM**  
DNA assembled CNT FETs

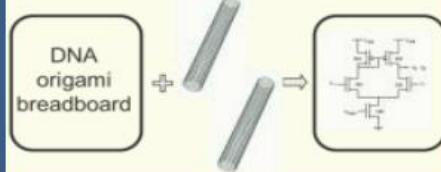


Diagram illustrating DNA assembled CNT FETs, showing the assembly of DNA origami breadboard and carbon nanotube field-effect transistors (FETs).

**HARVARD UNIVERSITY**  
DNA Storage



Diagram illustrating Cytomorphic Electronics Concept and DNA Storage, showing a cell with an integrated circuit and a DNA sequence.

2002

2004

2006

2008

2010

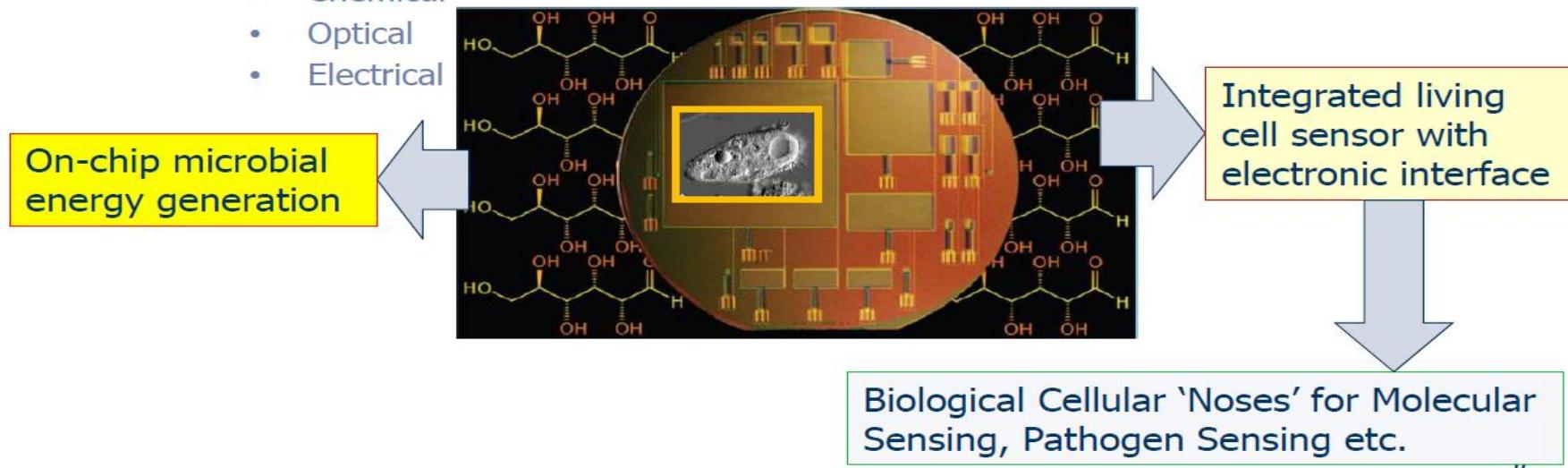
2012

# Example: Semiconductor/Biological Circuits



## Example II: Hybrid semiconductor/biological circuits

- Using 'cellular material' as intelligent components of electronic circuits
  - Digital, analog and sensing functions
  - Interfaces between biological and semiconductor components using different physical signals
    - Chemical
    - Optical
    - Electrical



# Future Health Challenges

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# Semiconductors Can Play a Role in the Future of Care



## CHIP WITH THOUSANDS OF PARALLEL INSPECTION CIRCUITS





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