

Ex vivo systems

Bioelectronics Research Round Table

Madoo Varma, Ph.D.

Director, Integrated Biosystems Lab, Intel Labs,
Intel Confidential, Intel Corp, March, 2010

Outline

Opportunities in Ex-Vivo analyses

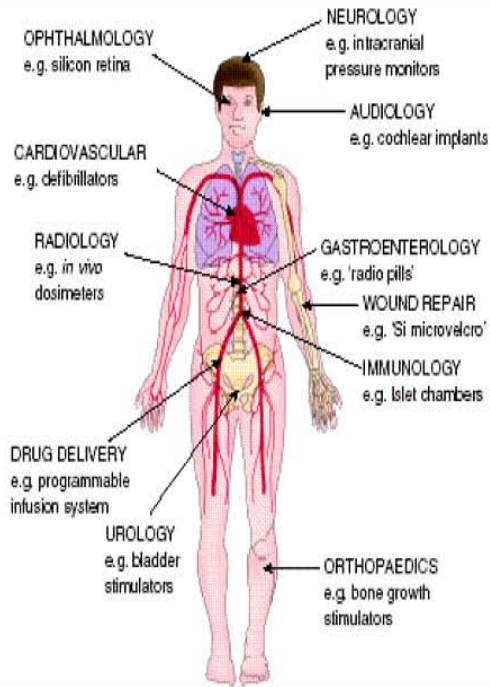
Need and challenges

DNA Analyses

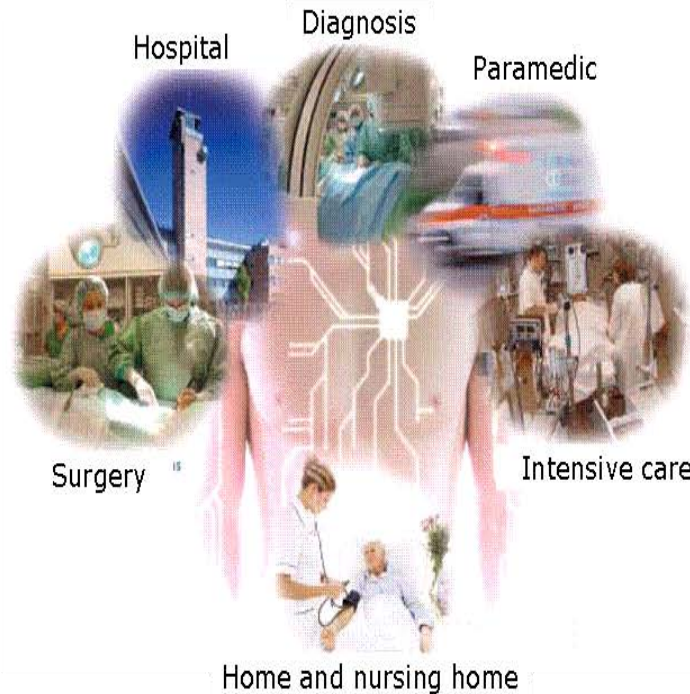
Proteomics analyses

Biosensors Are All Around Us

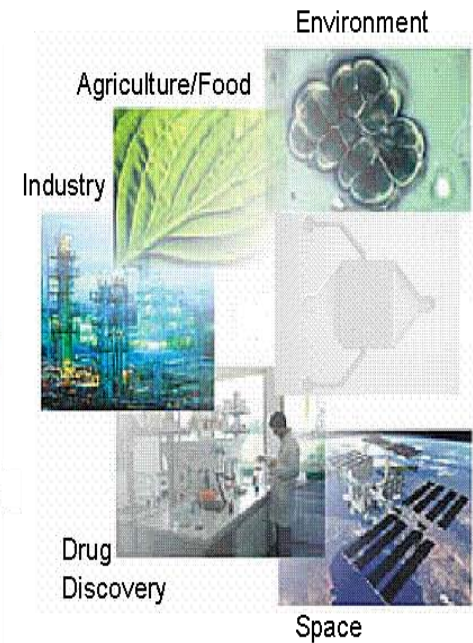
Within You



With You

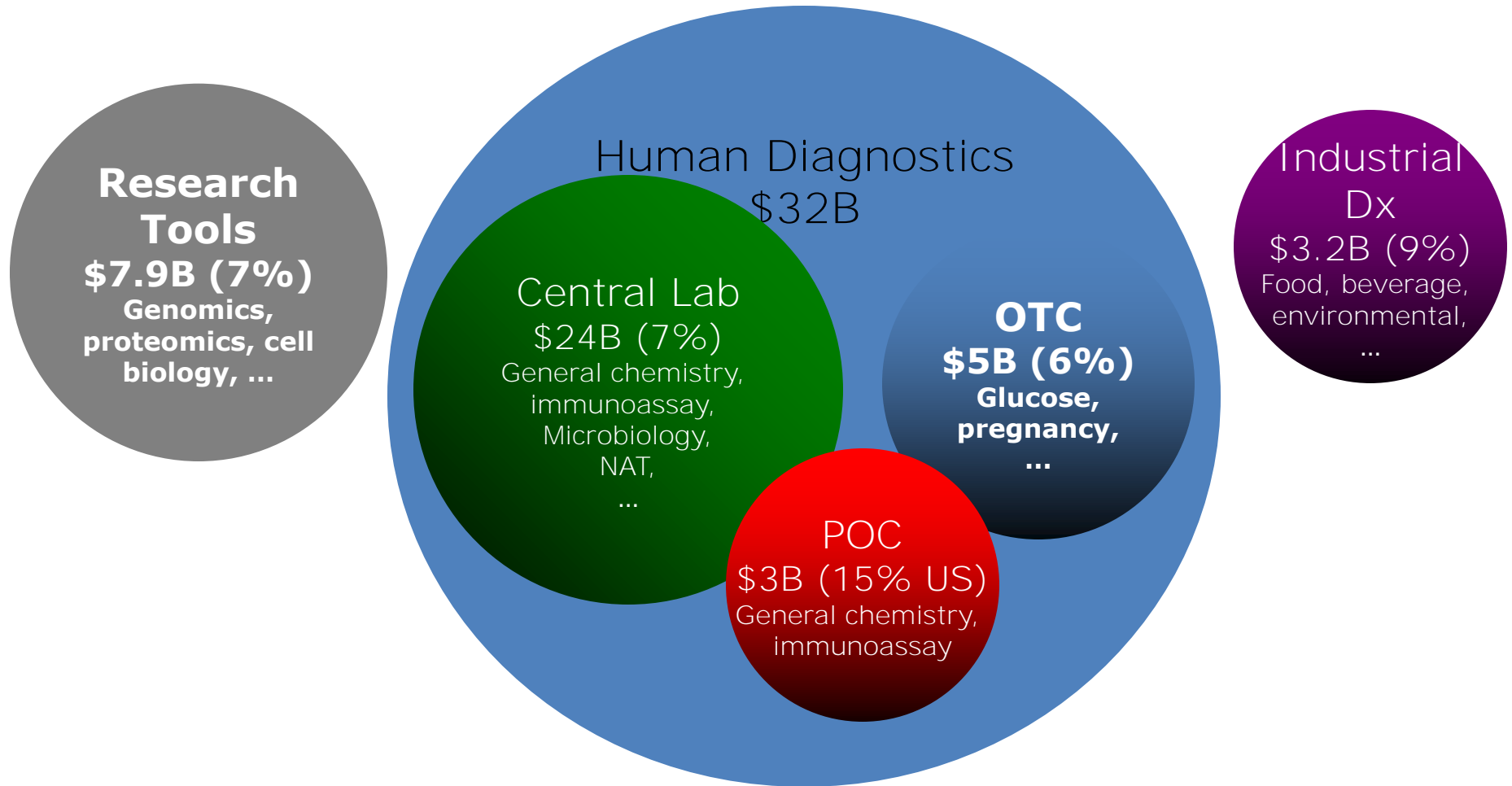


Around You



Ex-vivo or in-Vitro: in artificial assay conditions that mimic natural milieu)

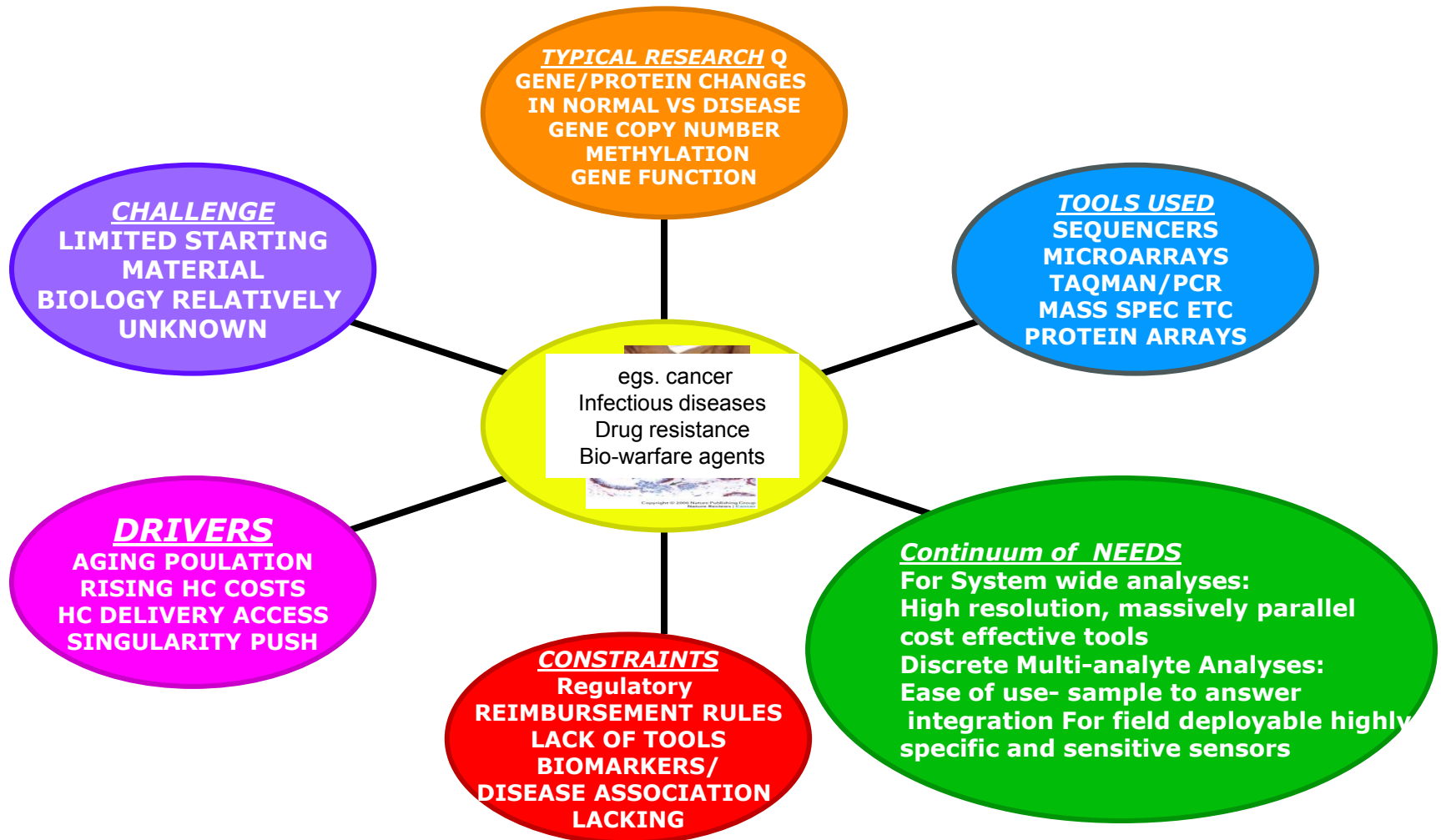
Industry Segments



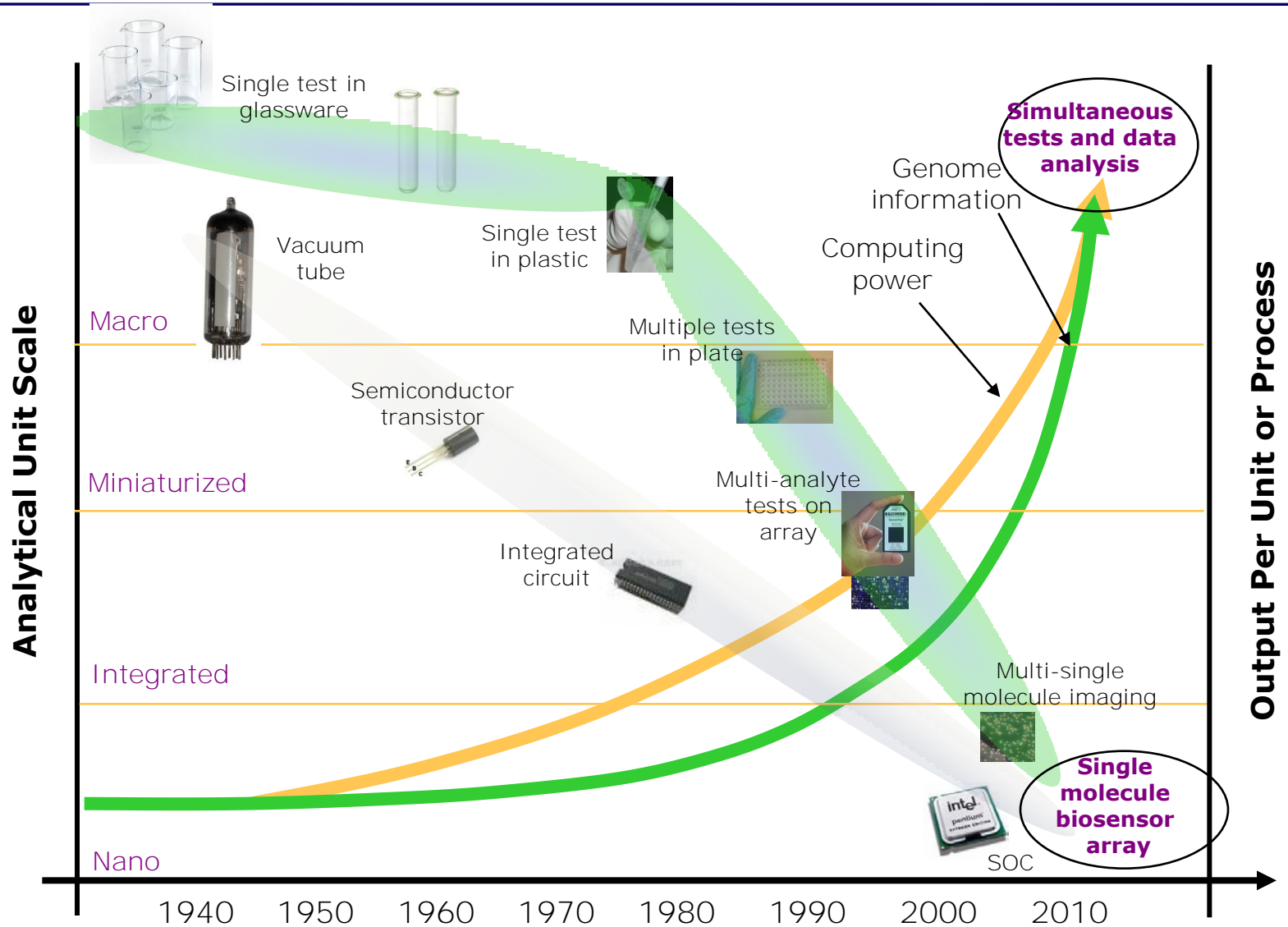
150B+ Medical Device industry not included

Key Challenges, Drivers, Constraints & Needs

In Biomedical Research, Diagnostics



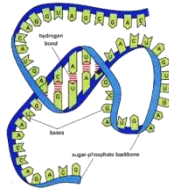
Opportunity for Convergence



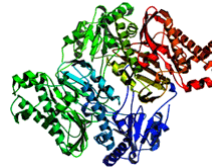
Biomolecules and the silicon components at similar length scales



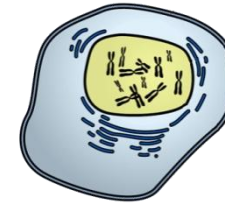
DNA:
Total 3×10^9 base pairs,
DNA is 2nm in
diameter, about 25,000
genes



**RNA: About
100,000
species**



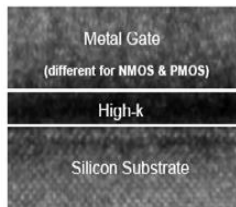
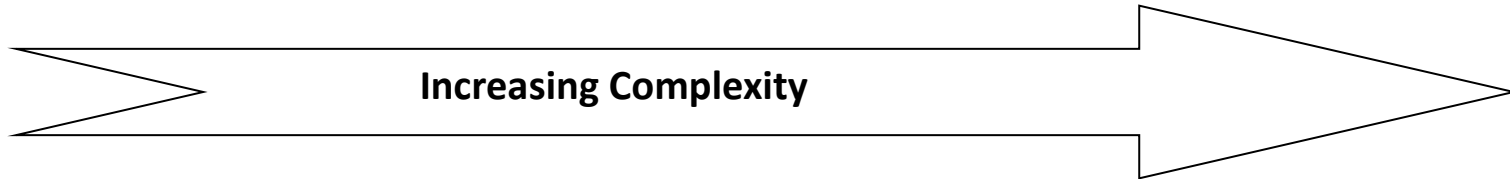
Protein:
More than 1,000,000
species and a Few nm in
size



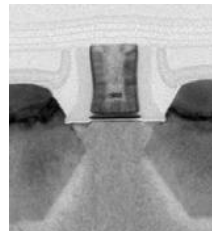
Cell:
10-100 μm in diameter,
 $>10^{12}$ cells in a human
body



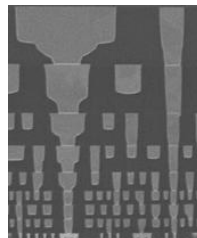
Organism



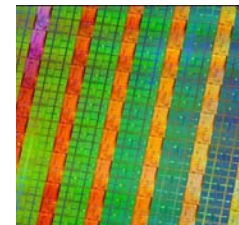
High-k dielectric film



45 nm PMOS



Interconnects

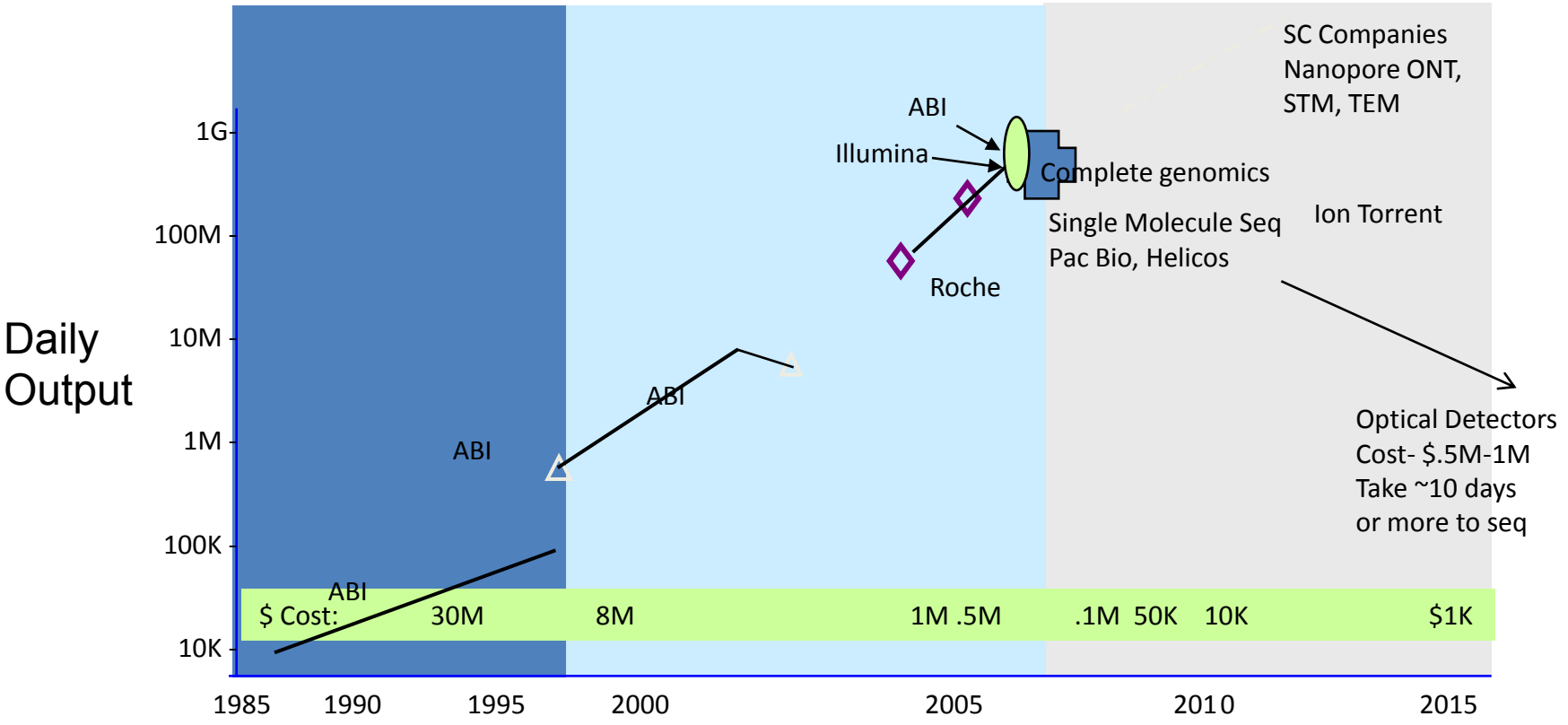


Processor



Computing Platforms

Sequencing Technology Disruption

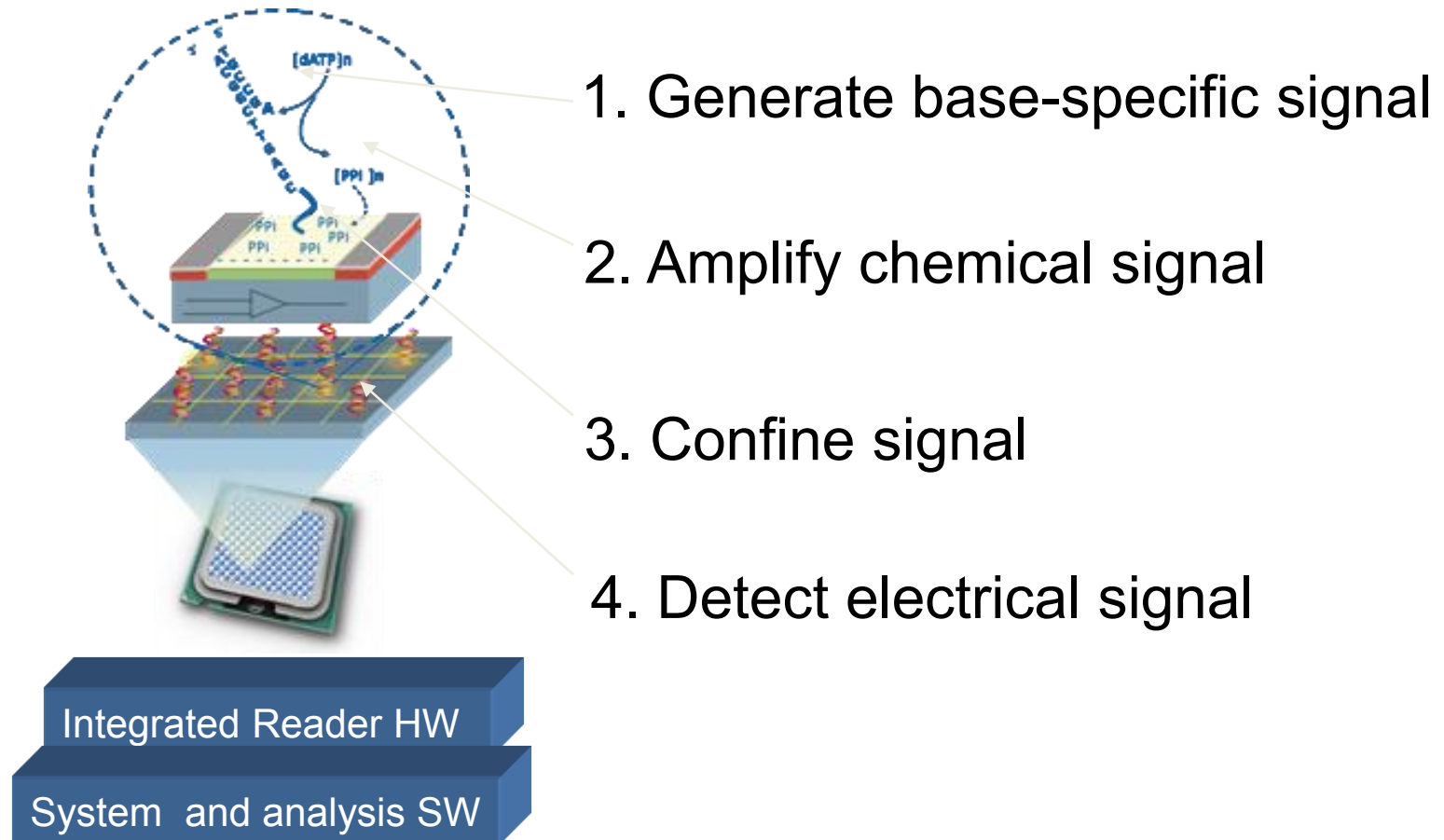


1K -

Ion Torrent pH, FET based, 454 chemistry, possible service model
 * Revised 2/4/2010 under construction- Madoo
 * Other names and brands may be claimed as the property of others.

Note: Complete genomics, Illumina and Life announced services @ 5-10K,

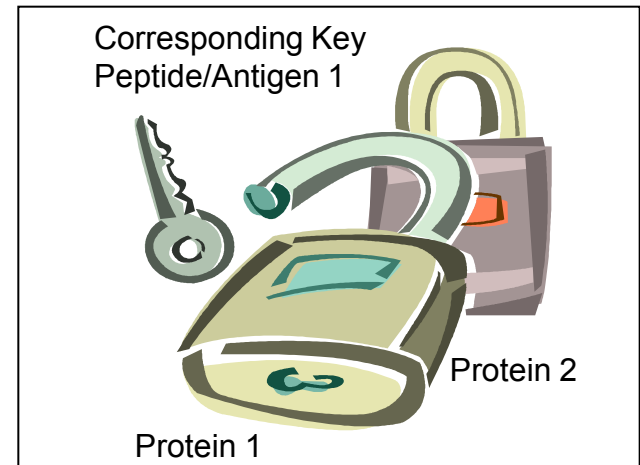
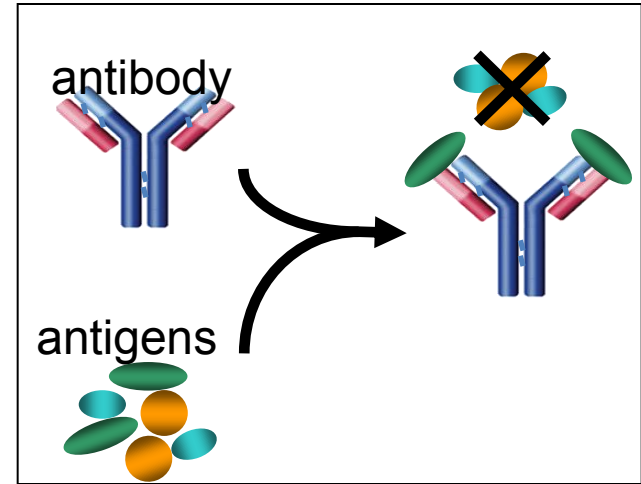
Intel Research Focus



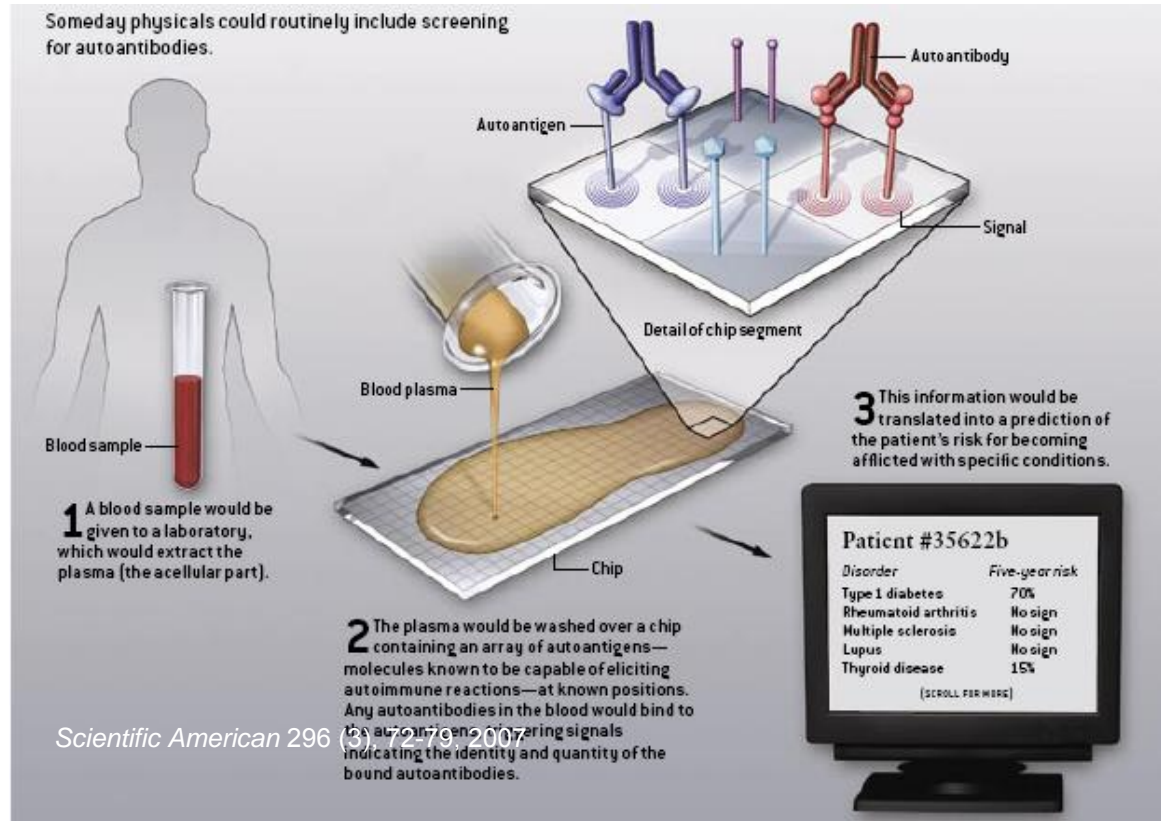
Label-free Low and high Density Electronic Arrays

Why study Proteins?

- Closest to action in the body; proteins important in maintaining cellular function
- Proteins interact with each other via a lock and key mechanism, abnormal interaction lead to disease
- Protein and peptide array can facilitate screening these interactions on large scale



Use of Arrays: Checkups of the Future

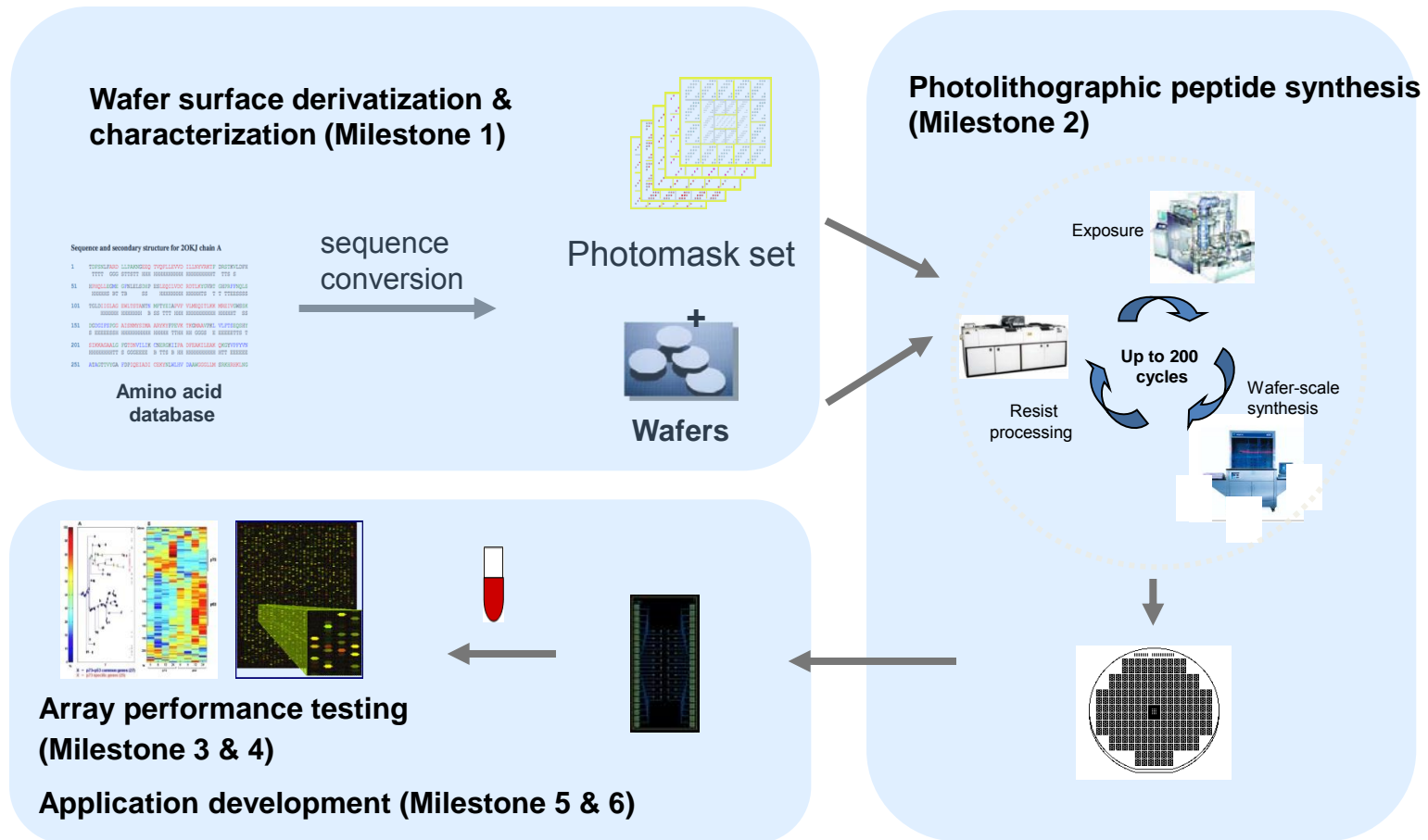


- Body's defends against foreign invaders by making antibodies proteins that attack foreign antigens
- However, some times body's antibody turns against itself & leads to autoimmune diseases such as R. Arthritis

1 Screening & profiling auto antibodies using auto antigen micro array can diagnose and predict autoimmune diseases

Peptide Array Project Process Flow

Develop silicon based peptide arrays for drug discovery and clinical diagnostics



This project combines two well-established technologies: semiconductor photolithography and peptide solid-phase synthesis

Ab mixture

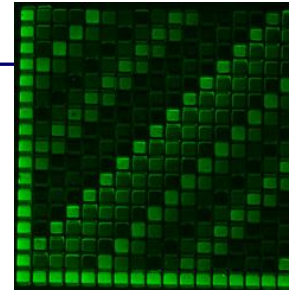
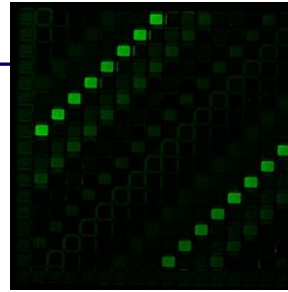
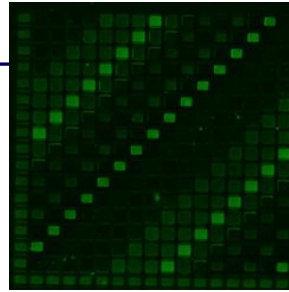
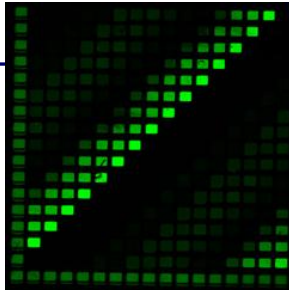
Immunovision

Patient A

Patient B

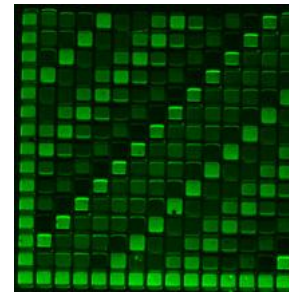
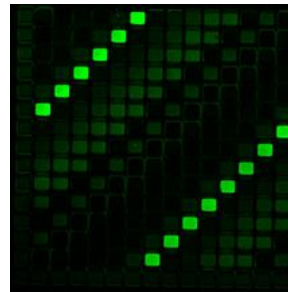
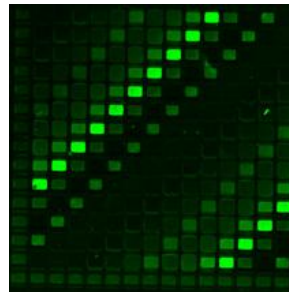
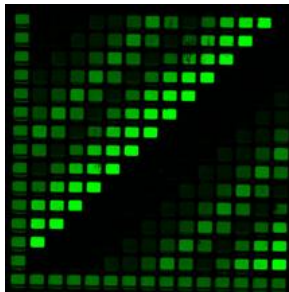
6AA

peptide



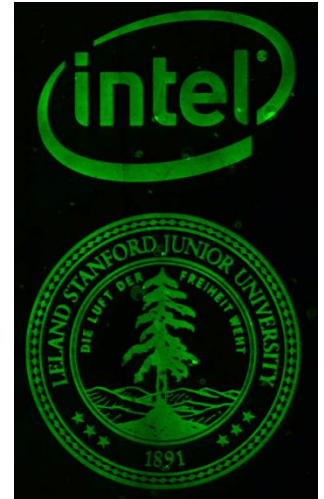
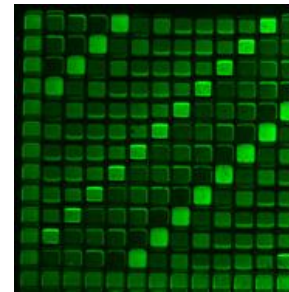
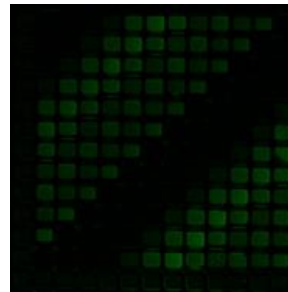
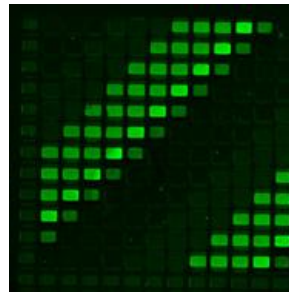
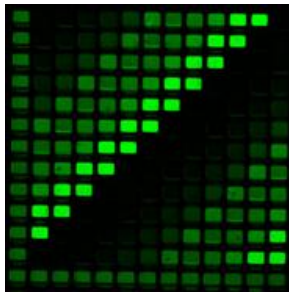
8AA

peptide



10AA

peptide



Photolithographic peptide microarrays on silicon wafers for screening patient protein profiles. Source: Intel Corporation, 2010

Opportunity and Challenges

- Bio-compatibility: understanding surface interactions at the intersection of biology and silicon
- Designing for manufacturability: Compatibility with standard CMOS fabrication methods
- Cost/Volumes for intended applications – modularity
- Low power and packaging requirements