Biomedical sensors in the pharmaceutical industry

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Health Care Industry

- **Pharmaceutical Industry/Big Pharma:**

  Fine pharmaceuticals: Innovative drugs; new targets, new MoA, better efficacy/safety

- Tangible products/industries:
  - Biotechnology
  - Diagnostics/analytical
  - Instruments, hardware, software
  - Devices

Equipment

Insurance

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What are biosensors?

- A biosensor is an analytical device which converts a biological response into an electrical signal
- Enzymes as the biologically responsive material
- Other systems may be utilised by biosensors: whole cell metabolism, ligand binding and ab-ag reaction

Features of a successful biosensor:

- Biocatalyst highly specific for the purpose of the analyses
- Reaction independent of physical parameters
- Response accurate, precise, reproducible and linear. No electrical noise
- Biocompatible
- Cheap, small, portable and capable of being used by operators
- There should be a market

(Ref: Lsbu.ac.uk: What are biosensors)

Rapidly expanding field

- 60% annual growth
- Health care industry is driving
- Food quality appraisal
- Environmental monitoring
- World analytical marked is about £12,000,000,000
- 30% in health care
- 0.1% is presently covered by products

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Biosensors: Early stage technology.

- Nano-enabled sensors (nano-particles, silicon nanowires, and nanogaps)
- Novel bio-optical sensors
- Miniaturized/implantable sensors

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Nano-enabled Biosensors

Nanoparticles:
Example: Nanosphere, Inc.

Founder: Chad Mirkin, Northwestern U.

Nanoparticles labeled with appropriate biomolecules are used both as capture probes for purification/concentration from a sample and signal amplification. Nanosphere has demonstrated detection more sensitive than existing technologies for a biomarker of Alzheimer's in clinical samples.[1]

Now marketed as the Verigene system.

Nanowires:
Example: Charles Lieber, Harvard U.

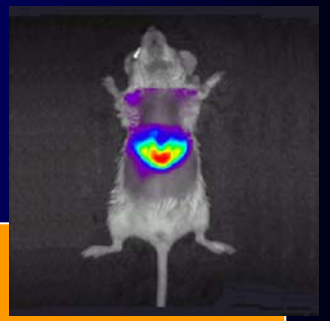
Silicon nanowires can act as field effect devices, with binding of biomolecules creating measurable electronic signals. This enables direct readout of biological signals (e.g. no optics and supporting instrumentation).

Detection of femtomolar concentrations of blood proteins with a multiplexed nanowire sensor.[2]

Detection of single viruses.[3]

1. Georganopoulou et al 2005. Proc. Nat. Acad. Sci. USA. 102(7):2263-2264
2. Zheng et al. 2005. Nat. Biotechnol. 23(10): 1294-301.
3. Patolsky et al. 2004. Proc. Natl. Acad. Sci. USA. 101(39): 14017-22.

Novel Bio-optical Sensors



Quantum Dots:
Example: Quantum Dots, Inc.

Nanoparticles that fluoresce with high quantum efficiency and without photobleaching. Dots can be engineered such that multiple emission wavelengths can be generated with a single excitation wavelength.

Applications primarily in early drug discovery.

QD, Inc. recently acquired by Invitrogen.

In Vivo Fluorescence:
Example: GE eXplore Optix

Use of long wavelength light (NIR) and fluorescent reporters that work in the body, e.g. protease substrates or GFPs, permits real-time, non-invasive detection of signals in vivo.

Other In Vivo Imaging:
Example: PET, MRI, Optical Tomography

Lots of examples in “Biophotonics International”
http://www.photonics.com/bio/XQ/ASP/QX/

Real time monitoring of molecular signaling processes in a live cell: optical nanobiosensors that can be inserted into single living cells

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Miniaturized/Implantable Sensors

Glucose Sensing:
Example: Animas Corp.

http://www.animascorp.com/products/pr_glucosesensor.shtml

Goal is to first provide real-time monitoring of blood glucose. Long-term goal is to provide real-time feedback for automated insulin dosing (artificial pancreas).

RFID tags:
Example: Digital Angel, Inc. .

Verichip technology, used widely in animal ID systems, entering human clinical trials for FDA approval. Provides patient ID and body temperature.

May/will replace bar coding

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Networked/Telecomm Sensors

Digital Angel™ CORPORATION

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New Gene Sequencing Technologies

New technologies for whole-genome sequencing – lower cost & higher throughput :

Example 1: 454, Inc.
www.454.com
Technology well explained at
http://www.454.com/pages/454%20Technology%20Updated%20Feb_2_2005/Website_update_2_01_05_files/frame.htm
Margulies et al. 2005. Nature 437(7057):376-80 demonstrates de novo sequencing (e.g. not re-sequencing) of a bacterial genome in about a day.

Example 2: Solexa, Inc.
www.solexa.com
Recently announced sequencing of a bacterial artificial chromosome (BAC).
http://www.bioportfolio.com/biotech_news/SOLEXA_1.htm

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Practical applications in medicine

- Discovery of measurable signals we can not measure (harmful pathogens; e.g. SARS, anthrax, smallpox, viral cancer)
- Diagnostic tests for personalised needs (glucose, Her +/-, osteoporosis, SNIPs)
- Early diagnosis: In combination with traditional technology (e.g. LIF with endoscopy)
- Real time info from patients; EEG, body temp., etc.
- Analytical: Ultrasensitive detection of chemical and biological species
- Drug delivery and monitoring; e.g. DES (drug eluting stents)

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Find new applications

- DNA sequencing
- Microarray (many bankruptcies already)
- Prognostics – in treatment
- Alien technology
- Drug counterfeiting (RFID)

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Biosensors and Big Pharma

- Part of technology platform (immunosensors, DNA probe)?
- Analytical/diagnostic/assay application?
- Strategic alliances?
- Horizontal integration in Health care industry?
- Big Biotech like Big Pharma?

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Obstacles

- Body interference
- Fibrotic capsule
- Toxicology: No clear outline yet
- Industry infrastructure
- ELSA
- Payors principle

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Biosensors in Norway

- No time to lose
- Already big industry in UK and US
- ”Killer application” history
- Success story welcome
- TV not invented in 1960
- Internet not invented in 1994

- Think big when you think small things

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