Biosensors for Animal Health Diagnostics and Pathogen Detection

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LRIC Cross Sector Research Meeting
April 14, 2015
Animal Health – The Missing Link?

Trends for Future

• From reactive to proactive, predictive and preventive
• Combination of in-vitro and in-vivo diagnostics
• Completion of diagnostics towards therapy and progress tracking

Source: http://soa.sys-con.com/node/2773793
Remote Monitoring of Livestock Housing

- Monitoring animal behaviour and environmental Interactions
- Surveillance system for monitoring diseases
- Detection of disease outbreaks at early stage
- Real-time monitoring of barn/or poultry farm conditions
Sub-Clinical Ketosis – Dairy Sector

- On-farm detection of Sub-clinical Ketosis from 10 micro-liters of blood
- Beta-hydroxy butyrate, Non-esterified Fatty acids (NEFA)
- Rapid and low-cost Quantum Dot based biosensing approach
- 20-fold reduction in reagent consumption
- Assay time reduction to 1 minute
- Superior sensitivity and specificity
Biosensor for Avian Flu Detection
Goals

1) To deliver 'Practical Solutions' in identified disease constraints for livestock

2) Integrated approach to control and/or prevent diseases which impose constraint to livestock productivity

3) Cross Sector - 'Generic Platforms' within the context of disease focus

4) Equipment/Tool and the pathogen detection module which can be applied to all partners of livestock
Pathogen Detection

Chemotactic Attractor

No Chemotactic Attractors or Repellants
DNA Analysis

- Most promising application of nanotechnology
- DNA analysis requires a lot of time, money and multiple labs
- Procedures – Extracting, Amplifying, Separating and Sequencing are portable techniques due to ‘Nano’
- Sample processing cartridge, evidence collection device with a collecting swab, tube for swab insertion, cartridge for analysis, biochip for DNA processing, Signal output
- Genotyping system – 13 locations in the genome of an individual display patterns ‘Unique’ to the species.

Source: Ben-Yoav et al., (2015)
Low Cost Point of Care Food Allergens Sensor

- Screening of Antibiotic Residues testing in Poultry, Beef, Pork, Chicken and Turkey Birds
- Screening and detection of hormones from livestock
Salmonella spp

- **Salmonella**, an important cause of human illness in the United States and often linked to livestock sector

- **Salmonella Heidelberg** - non-typhoidal

- 1.2 million illnesses, 23,000 hospitalizations, 450 deaths, and an estimated-$365 million in direct medical costs in North America

- **Salmonella Enteritidis**, especially phage type 4, has become much more common in both poultry (all livestocks) and humans since the early 80s
On Farm Strategies

• Testing and removal for *Salmonella*
  • Serologic, fecal culture, hide culture

• Vaccinating
  • Many serotypes
  • Varying effectiveness

• Minimize rodents, wild birds

• Isolation of new animals
# Diagnostic Technology Assay Platforms

<table>
<thead>
<tr>
<th>Platform</th>
<th>Purpose</th>
<th>Science and Technical Input</th>
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<td>Analyte Identification</td>
<td>To identify pathogen molecules, usually protein or DNA, which are incorporated into a diagnostic assay. These molecules are: (a) unique to the target pathogen, (b) detectable in easily obtained samples from the host</td>
<td>Bio-Instrumentation&lt;br&gt;Nanotechnology&lt;br&gt;Biological Engineering&lt;br&gt;Microbiology&lt;br&gt;Protein chemistry&lt;br&gt;Recombinant DNA technology&lt;br&gt;Pathogen genetics/evolutionary biology&lt;br&gt;Genomics/bioinformatics</td>
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<tr>
<td>Diagnostic Assay Platforms</td>
<td>To facilitate analyte detection in routine laboratories or in the field. Commonly used technologies include: a) ELISAs&lt;br&gt;b) Polymerase Chain reactions&lt;br&gt;c) ‘Pen-side’ tests, such as lateral flow devices&lt;br&gt;d) ‘Mobile Phone (Smart Phone) technology’ to extend diagnostic capacity</td>
<td>Microfluidics&lt;br&gt;BioNanotechnology&lt;br&gt;Biomedical / Biological Engineering&lt;br&gt;Instrumentation</td>
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Future Trends

- Concept of Biosensor animal health diagnostics is embedded in engineering and science and not a fiction

- Diagnostic tools will provide only part of the solution, but their impact will depend on the management infrastructure into which they are deployed

Trends are towards

- Miniaturisation (POC devices), greater sensitivity, increased speed, decreased cost

- Multiplexing/microarrays

- Novel biomarkers

- Improved ICT capabilities at reduced cost

- Interoperability, Affordability and User friendliness
Way Forward…

Shape the future of animal health monitoring and animal welfare and production systems through

- identification of risks and preventing disease outbreak
- diagnose diseases early at their onset
- enable efficient therapies with measurable outcomes

Near-Term Goals:

- Very important to bring along all stakeholders
- *Salmonella spp* is a high risk pathogen across livestock sector
- Detection and identification of risk factors of *Salmonella spp*. prevalence, concentration and contamination
BioNano Team

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Xuan Weng  Rekha Albert  Adam Mungroo  Murugan  Evan Wright
Acknowledgments