Product Authentication and Anti-Tampering Solutions for Packaging

DR. EVANGELYN ALOCILJA, Professor,
Department of Biosystems and Agricultural Engineering, MSU

Agenda

- Introduction
- Project Scope
- Impact of Research
- Value to Industry
- Current Results
- Future Direction
- Project Plan

Introduction

Project Team:

PI:	Co-Investigators:	Sponsor:
Evangelyn Alocilja	P. Chahal, E. Almenar, B. Day, J. Wilson, D. Closs, T. Schoenherr, & C. Mena	Jeff Tazelaar, The Dow Chemical Company

Project Scope

Grand Challenge: Public protection against counterfeit and fraudulent products

Expected Outcome: Lock & Key multi-level authentication technologies

Research Objectives:

1. To assess the current state of the art of (a) ACTs, (b) nanomaterials for tagging, (c) DNA sequences for tagging, (d) RFID and smart phone readers, and (e) FDA regulations and standards on ACTs; and assess potential constraints for industry adoption of the proposed technology.

2. Synthesize nanoparticles infused with serialized DNA sequences to form product DNA barcodes (PDBs) for specific company and product information; design RF tags, nanoparticle readers, and blockchain-like cryptographic algorithms and interrogation protocols.

3. Integrate PDBs and readers in the blockchain-like network and validate the efficacy of the PDB system in drug, food, and luxury goods supply chains.

Impact of Research

- Counterfeit goods (“knockoffs”) exist in virtually every form of consumer product.
- Rapidly growing underground industries in the world with cheap overhead, high profit, clandestine business style, and aggressive fraudulent distributors
- Counterfeit products account for about 5-7% of world trade, worth an estimated US$600 billion per year
- Some counterfeiting operations are linked to organized crime and terrorist activities
- Fake and substandard drugs serve as *de facto* weapons of mass destruction and a crime against humanity
- Drugs pass through a long and complicated distribution network, thereby creating opportunities for counterfeits to enter the legitimate supply chain

Value to Industry

Our proposed Lock&Key technology will:

Reduce trademark theft

Detect product substitution or dilution

Reduce "3rd shift" illegal manufacture or illegal acquisition of legitimate goods

Prevent legitimate products from diversion

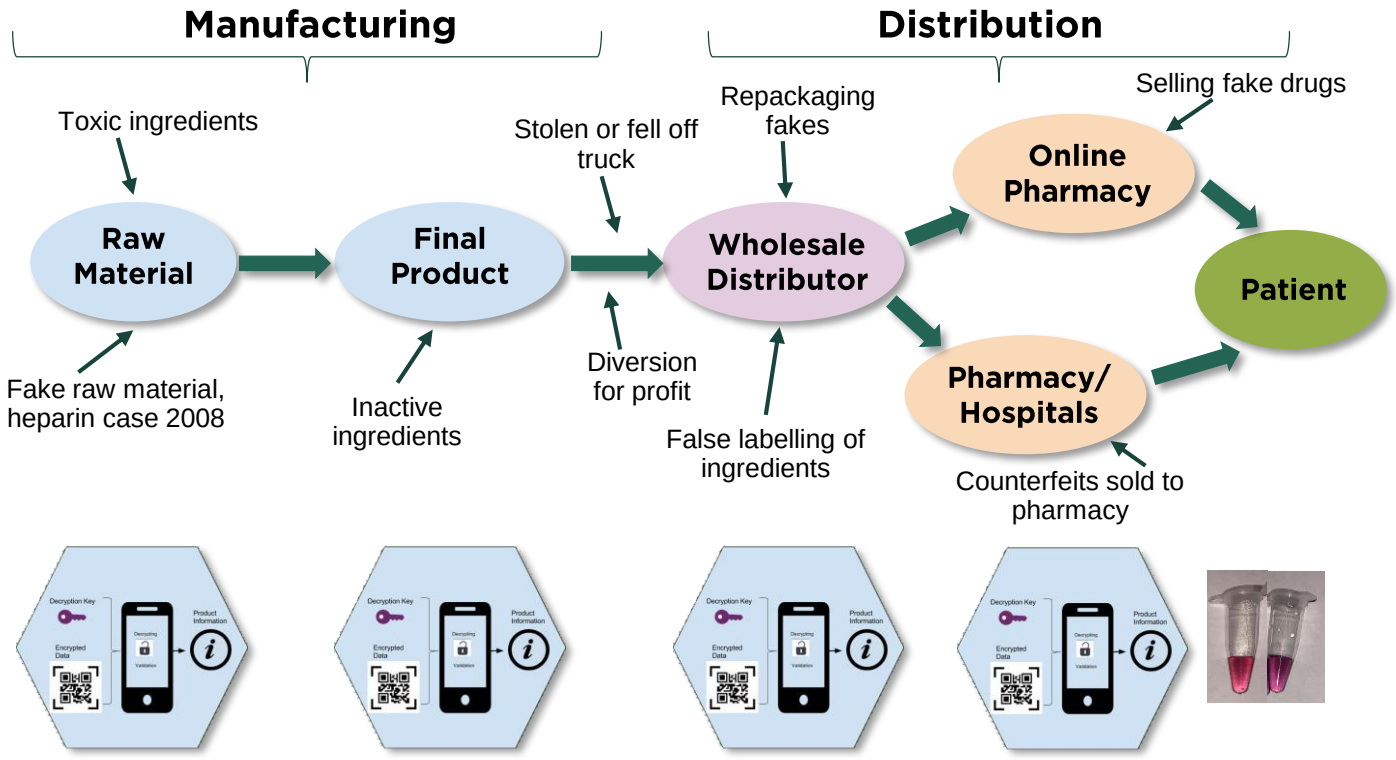
Anticipated benefits to society:

- Reduce deaths caused by false drugs
- Reduce antibiotic resistance caused by under-dosing
- Reduce deaths due to false products
- Increase revenue from legitimate goods
- Improve legitimate trade

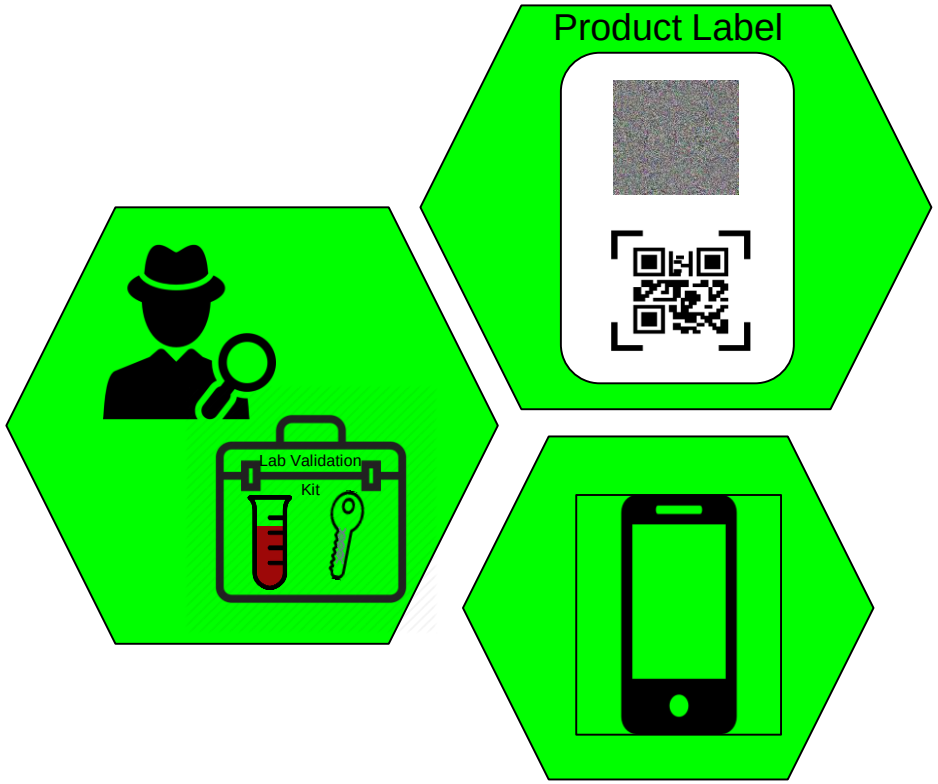
Value to Industry

Our proposed Lock&Key technology will support the integrity of supply chains

Example: Lock&Key technology in the pharmaceutical supply chain



Value to Industry



TECHNOLOGY BUNDLE:

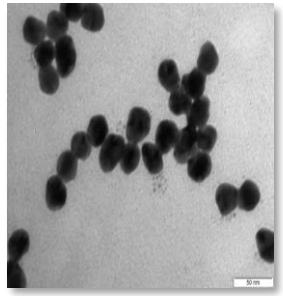
1. Product label
2. RF tag and reader
3. Serialized DNA-AuNP test kit
4. Product label reader
5. Blockchain-like cryptographic algorithm and cell phone app

With our proposed multi-level authentication technology, we hope to reduce counterfeit products in the market by 10%, generating revenue of about US$60 billion per year.

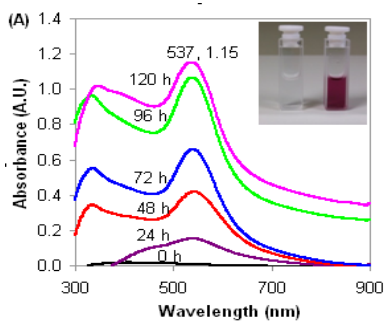
Current Results

INTEGRATED APPROACH:

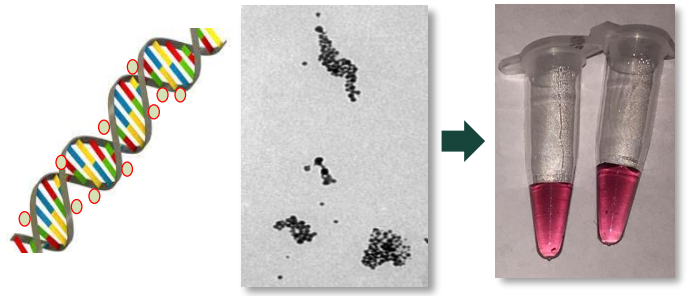
1. Physical features
2. Digital fingerprint
3. Serialization
4. Multi-functional authentication scheme



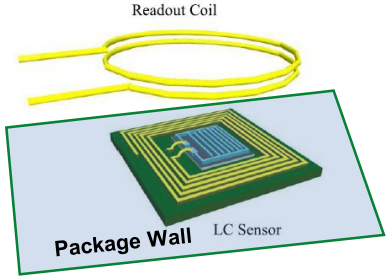
Transmission microscope (TEM) image of our gold nanoparticles (AuNPs), 30 nm in diameter



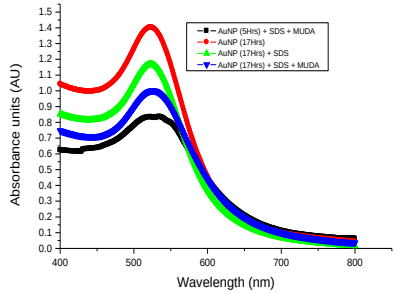
Physical Features: Wavelength spectra of the AuNPs. Inset: Red color of AuNP solution after synthesis



Digital Fingerprint: Schematic (left) and TEM image of synthesized DNA strands coated with our AuNP (DNA-Au) (middle)



Wireless RF tag



Red color of AuNP solution

Color of lock with 1 key

Color of lock with 2 keys

Color of lock with wrong keys

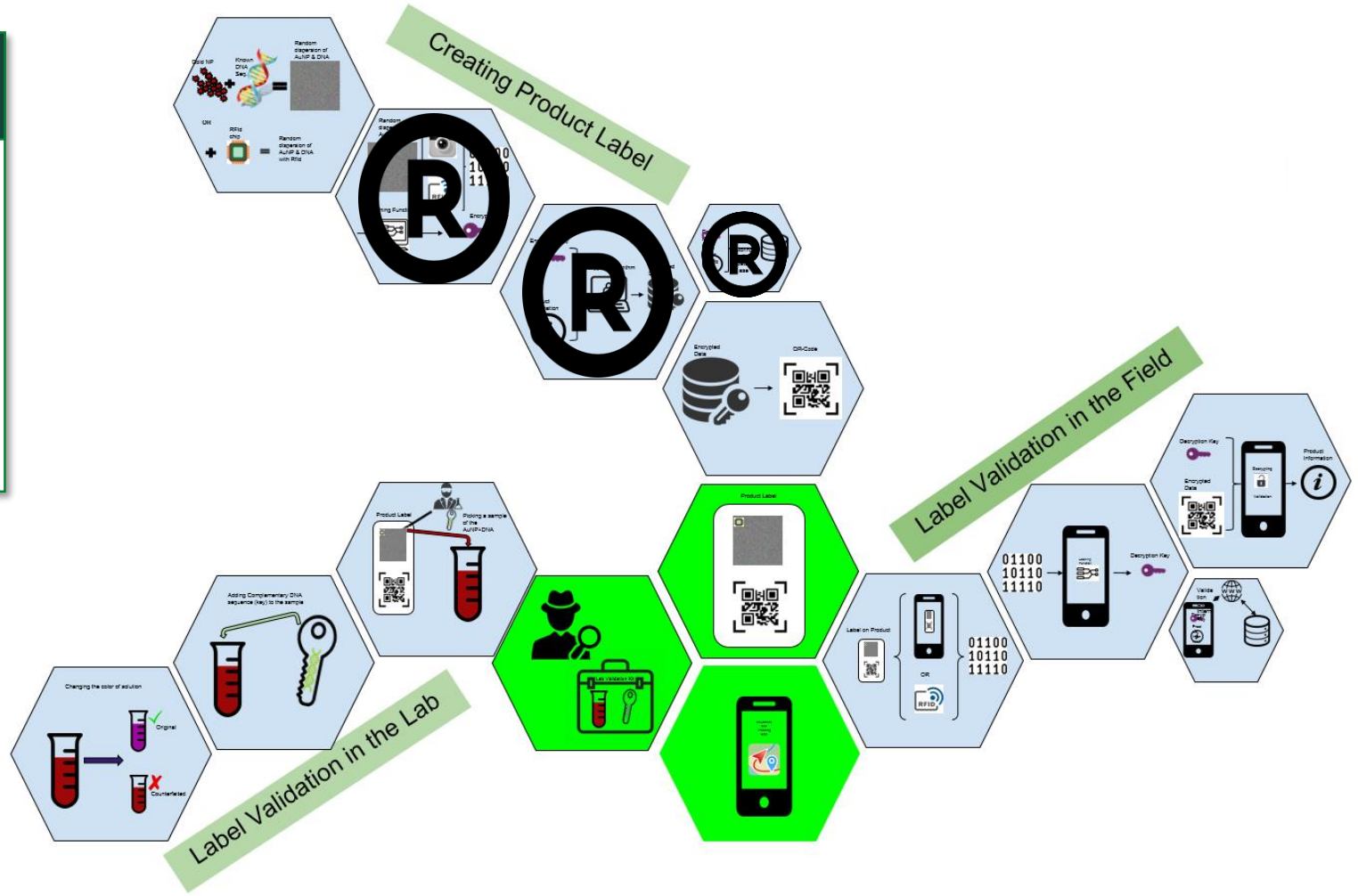
Au-DNA lock & key colorimetric system

Current Results

Lock&Key Multi-Level Authentication Technology

TECHNOLOGY BUNDLE BEING DEVELOPED:

1. Product Label
2. RF tag and reader
3. Serialized DNA-AuNP test kit
4. Product label reader
5. Blockchain-like cryptographic algorithm and cell phone app



Presentations

1. Jones, R., Cannon, T., Vasher, M., Baetsen-Young, A., Day, B., Alocilja, E. 2017. DNA Detection Using PCR-less Methods, University Undergraduate Research and Arts Forum, Michigan State University.

2. Cannon, T., Jones, R., Bhusal, N., Bhattarai, R., Alocilja, E. 2017. PCR-less DNA Detection Using Functionalized Gold Nanoparticles. Mid-Michigan Symposium for Undergraduate Research Experiences (Mid-SURE), Michigan State University.

Future Direction and Project Plan

Timing	Project Plan Activity
Jan-Dec 2018	Design product-specific DNA sequences and serialization codes
July-Dec 2018	Infuse DNA sequences into gold nanoparticles
Oct 2018-March 2019	Develop DNA-AuNP test kit
Onward	Create the product label
Onward	Develop label reader
Onward	Develop hashing and encryption algorithms
Onward	Develop the cell phone app

Thank you