2014 FDA Food Safety Challenge

Background reading on Testing Technologies

BACKGROUND READING ON TESTING TECHNOLOGIES

Note: The below is provided for informational purposes only.

Current State of the Art

In order to identify and confirm the presence of pathogenic bacteria in a given food sample, scientists must follow testing procedures. With the rapid ongoing development of new measurement instruments and materials, these procedures are in flux. While the Challenge solicits concepts for testing procedures that will speed the time to confirmed result, it is helpful to understand the FDA's current testing procedures and capabilities.

Until relatively recently, there were three standard methods of pathogen identification: **culture** (colony counting), **polymerase chain reaction (PCR)**, and **enzyme-linked immunosorbent assay (ELISA)**. Because ELISA is not a standalone method, the FDA most commonly uses culture and PCR to evaluate food samples. These methods differ in approach. Culture is the most technologically simple but time consuming method, in which bacteria are cultured (grown) in a growth medium and then counted. PCR is a nucleic-acid based approach that can identify bacterial DNA. ELISA uses a solid-phase enzyme immunoassay (EIA) to detect the presence of a substance in a given sample.

Each of these "standard" methods has strengths and drawbacks, and though more rapid forms of PCR are in development, all three generally take between several hours and several days to confirm a result. As such, the FDA is soliciting techniques to improve the speed of detection efforts. The following (often overlapping) technology areas are highlighted for their promise in food safety applications, but innumerable advances in modern science could be applied and the FDA looks forward to seeing diverse examples of American ingenuity and innovation in the submissions.

Technology Areas

Electrical Detection (i.e. bioMEMS)

Researchers are working to develop detection systems that can both specifically identify bacterial organisms as well as provide electronic readout from highly-sensitive sensors that ideally do not require labeling (tagging the target pathogen in order to identify it). Electronic biosensors have promise in this area; particularly the development of BioMEMS, biological microelectromechanical systems used to develop "lab-on-a-chip" biosensors.

Nanotechnology (i.e. carbon nanotubes)

Nanotechnologists are able to develop materials and procedures with strange properties by manipulating matter at the atomic level. One of the most promising advances in nanotechnology concerns the application of carbon nanotubes, a unique arrangement of carbon atoms into miniscule tubes with unique thermal, conductive, electrochemical properties. Carbon nanotubes and other nanotechnology advances are exciting for the development of new biosensors to detect pathogens.

Quantum Detection (i.e. quantum dots)

Similar but distinct from nanomaterials, which manipulate matter at the atomic level to make use of unusual emergent material properties, quantum phenomena occur at the subatomic scale. While still a nascent field of inquiry, some quantum mechanics work may find early application in pathogen detection efforts. Particularly promising is the use of quantum dots — nanocrystals made of semiconductor material which exhibit unique mechanical properties — to label and identify distinct organisms. These nanoparticles serve as fluorescent labels that have promise in replacing the use of organic dyes in identifying target pathogens.

Spectroscopy

Spectroscopy is an optical sensing technique that uses light refraction to detect and identify materials at the molecular level. In most modern applications, this involves shooting laser light at a substance and measuring the pattern of refraction, which serves as a unique molecular signature. Particularly promising for pathogen detection, surface-enhanced Raman spectroscopy allows the detection of single molecules. While as a field of study spectroscopy is more than 100 years old, the ongoing development of more precise instrumentation and the application of previously-unavailable tools (such as terahertz radiation) make this a promising approach to improving pathogen detection methods.

Metagenomics

Metagenomics is the study of all microorganisms in a given environmental sample. A single rapid throughput analysis can identify several thousand to millions of microorganisms by extracting all of the DNA within a sample and comparing it to a database. An important part of the work here concerns the development of genomic databases to inform and enable these analyses, making informatics an important element of metagenomics.

These are just some of the advanced technology areas relevant to food safety. The FDA is looking for submissions from across disciplines and technologies. Have a great idea for a novel pathogen detection technique? Submit to the Challenge!