Research Interests

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1. Biological Functional Proteomics / Systems Biology

I have being actively establishing protein databases via the proteomics approach. During the past five years, I have established various proteomic profiling including various cells, tissues, body fluids, and even microorganisms (anthrax). I have streamlined a proteomic system including 2-dimensional electrophoresis, mass spectrometry and protein analysis bioinformatics in the Department of Dermatology at UAB. With these technical tools, we are identifying and characterizing proteins on a large-scale, high through-put manner. Although proteomics can be a powerful approach to identify real-time expression of specific proteins and their isoforms within a biological domain, the function of each protein identified through proteomics in real biological systems still need to be addressed. That is why the so called "Biological Functional Proteomics or Systems Biology" will be a key step in applying proteomics to reveal biological phenomena. Thus the biological functional proteomics will be listed in one of my future research presentations.

Biological Functional Proteomics or Systems Biology will include:

(1) protein-protein interactions,
(2) protein involved in signal transduction, and
(3) protein contributions to biological phenomena.

II. Needle-free Noninvasive Vaccination

Traditionally, the administration of a vaccine usually requires one or more needle injections performed by trained medical personnel. The concept of a needle-free noninvasive technology may reduce medical costs by allowing personnel with limited medical training to administer the vaccine. Furthermore, the use of noninvasive routes for vaccine delivery such as the bare skin or the nasal cavity may be advantageous for vaccination since there is a large amount of associated lymphoid tissue and antigen presenting cells (APCs) near the skin surface. My laboratory has been demonstrating that animals can be effectively immunized by epicutaneous or intranasal applications of either adenovirus- or *E. coli*-vectored vaccines. The noninvasive vaccines we have been generating include anti-tetanus toxin and anthrax vaccines. My laboratory has identified and characterized a number of anthrax germination-associated proteins by proteomic profiling of anthrax germinating spores. Some of these germination-associated proteins have been cloned into our vectors to be tested as vaccines. Although

several of these noninvasive vaccines effectively elicit robust antibody productions, many puzzles or obstacles in the technique remain questionable and need to be clarified.

Research interests on this part are:

(1) to understand the mechanism of noninvasive vaccines.

Via proteomics, we now know that heat shock protein (HSP) 27 participates in adenovirus-vectored epicutaneous vaccination. The vast array of proteins induced by different vaccines in the skin, nose, or lung represent a hotbed of possibilities that may shed light on a nonstop dialogue between vaccination sites and environmental microbes that have been poorly understood up till now.

(2) to improve the efficiency and safety of noninvasive vaccines

Although two vectors (adenovirus or *E. coli*) have been successful in my laboratory in the construction of noninvasive vaccines, their efficiency and safety need to be improved. Finding alternative microorganisms such as baculoviruses or strain-related micro-organisms as vectors may be necessary. Improving the efficacy of delivery such as the application of harmless adjuvants or positively enhancing the permeability at the site of immunization is also listing in my future studies.

III. Microbiology

Contemporary anti-anthrax remedies focus on the tripartite toxin protective antigen (PA)-lethal factor (LF)-edema factor (EF) that is produced during the multiplication of the vegetative form of *Bacillus anthracis* in the host. Although targeting PA has proven effective to varying degrees of success in counteracting anthrax, it is unknown whether any of the PA-targeted methods can protect humans against inhalational anthrax during a massive onslaught of airborne anthrax spores. Furthermore, spore germination is an upstream event during the life cycle of *Bacillus anthracis*. Arrest of germination will preclude any downstream events including the production of PA-LF-EF. I envision that targeting *Bacillus anthracis* spore germination-associated proteins may be a more effective approach at combating anthrax than targeting the PA-LF-EF toxins; minimally, it may add an extra layer of protection. To date, I have identified numerous anthrax germination proteins by employing the proteomics approach. These germination proteins have served as novels antigens to construct new anthrax vaccines. The central dogma of microbiological proteomics: → novel antigen finding → vaccine development has been well-established in my laboratory. Thus this technique workstation will be applied for:

(1) screening novel antigens from other microorganisms for potential vaccine development.