potential liability risks of non-GMO products. Product liability risks include potential increases in carcinogenic mycotoxins, such as aflatoxin, which may concentrate in milk or meat (unlike the rDNA in digested GMO ("biotech") feeds). The comparative product liability risks of rDNA ("biotech") and non-biotech choices may actually dictate the use of biotech. Moreover, environmental liability risks may be reduced by biotech feeds (e.g., low-phytate soybean meal to reduce phosphorus in animal waste); the EPA could require such feeds as the "best available control technology". Companies may find that rDNA plant breeding, on a case by case basis, minimizes the environmental impacts of the traditionally bred crops and their associated inputs. Finally, assuming equal safety profiles for biotech and non-biotech feed, a company that goes "non-biotech" risks consumer fraud liability. An affirmative "non-biotech" representation should follow an agreed standard acceptable to all stakeholders. Without careful legal and scientific management of the process behind "non-biotech" representations, companies face fraud suits over unwanted "biotech" content. Until regulators endorse a process for non-biotech certification, dropping the "tolerances" for DNA content in food or feed (i.e., a process standard comparable to USDA's new Organic Rule), the risks of going non-biotech may often outweigh the benefits. Consumers know about biotech content from intensive media campaigns, so biotech content without a non-biotech claim is not a fraud risk. Since some consumers will ignore reduced mycotoxins and improved environmental performance in favor of non-biotech sources of food, regulations should ensure peaceful co-existence between organic farming and commercial agriculture, but ensure continuing innovation that reduces product liability risks, environmental impacts, and consumer fraud.

Key Words: Food biotechnology, Food safety, GMO

233 Economic and practical considerations of using non-biotech grain in U.S. livestock and poultry feed. Scott Richman*, *Sparks Companies, Inc., Memphis, TN.*

Given concerns about the continuing acceptance of agricultural biotechnology among U.S. consumers, some companies may consider offering for sale meat and poultry produced from animals which were fed only non-biotech grains and protein meals. This avenue may be considered as a way to protect a company's market share in the event that U.S. consumer attitudes toward biotechnology turn negative, or it may be seen as an opportunity for a company to serve a niche market of consumers who prefer "natural" foods and are willing to pay a premium. Yet,there are practical considerations which constrain the ability of livestock and poultry firms to offer meat and poultry certified as coming from animals fed only non-biotech corn and SBM. At the farm level, biotech varieties of corn and soybeans have been adopted widely across the U.S. At the grain elevator, corn mills and soybean crushing facilities, grain from different sources is commingled. Many animal feeding operations would face challenges unless they switched entirely to non-biotech feeds. There would be difficulty in keeping the resulting meat separate from commodity meat in packing and processing plants. The objectives of this talk are to describe the constraints which exist in the current supply chain, to indicate the steps which must be taken if those constraints are to be overcome, and to estimate the costs involved with undertaking such an effort.

Key Words: Economic, Biotechnology, Livestock

234 Effects on Global Trade: Setting International Food Standards via Codex Alimentarius. Mark Mansour*, *Attorney and Partner, Keller and Heckman LLP, Washington, DC.*

Although the Codex Alimentarius Commission has functioned as part of the U.N. Food and Agriculture Organization since 1962, its activities, until recently, were of little more than incidental interest to the international food and feed industries, especially U.S.-based multinationals. However, with the advent of the World Trade Organization (WTO) and the establishment of NAFTA and other regional trading blocs, Codex's deliberations became significantly more important to government and industry alike. As manufacturers realized that Codex, in the absence of any other mutually acceptable arbitral mechanism, would be enshrined in the WTO as the means by which disputes over trade in food products would be resolved, member countries also realized that the Commission would provide a solution to the growing gaps in their food regulatory structures. Lesser developed countries lacking both the expertise and the budgets to fully develop food regulatory structures adequate for both the protection of public health and streamlining the free flow of goods found such expertise through the 37 year long deliberative process, during which period they have institutionalized in their own regulatory regimes the experience gleaned from delegates representing the industrialized countries of North America and Europe. Despite the progress made in many countries toward developing coherent food legislation and regulatory structures, there remain significant gaps in the laws of many jurisdictions, particularly in Asia, the Middle East and Latin America, as well as persistent confusion about the legality of ingredients, additives and preservatives, and the propriety of various types of claims. In no functional area have these developments been as vital as in the area of biotechnology where, during the course of the next year, Codex is poised to make a series of decisions that will have a significant, and perhaps irreversible impact on the future of the global trade in food and feed products derived from biotechnology.

Key Words: Biotechnology, WTO, Food trade

Genetics of Disease Resistance

235 Transgenic approaches to prevent bovine mastitis. D. E. Kerr*[1], K. D. Wells[2], and R. J. Wall[2], [1]*University of Vermont, Burlington, VT,* [2]*USDA-ARS, Beltsville, MD.*

Transgenic animal technology is a strategy likely to play a major role in the prevention of animal disease. One approach is to enable the production of novel antibacterial proteins by the mammary gland as a means to enhance mastitis resistance. To this end, we have produced transgenic mice that have the ability to produce a bioactive variant of lysostaphin in milk. Lysostaphin, which is normally produced by *Staphylococcus simulans*, has potent staphylolytic activity. The lysostaphin-transgenic mice exhibit substantial resistance to staphylococcal mastitis. Fortification of milk as a strategy to enhance disease resistance has also resulted in reports of transgenic mice whose milk contains human lysozyme, bovine tracheal antimicrobial peptide, or a neutralizing antibody to a strain of murine hepatitis virus. We are currently evaluating additional antimicrobial proteins as candidates to be secreted by the mammary glands of transgenic animals. Our selection strategy is based on a number of parameters. First, there must be no indication of toxicity to eukaryotic cells. Second, the selected protein or peptide must be effective in milk in reducing the growth of mastitis pathogens. Milk components such as negatively charged casein micelles, and milk fat globule membranes can markedly reduce the activity of cationic antimicrobial peptides. Third, antibacterial activity must have limited or no enzymatic activity against milk proteins to ensure product quality. Fourth, the mammary epithelium must be able to produce the protein of interest in an active form. For many antibacterials this will likely require additional genes to enable post-translational processing and activation. Fifth, activity against bacteria normally used in the production of fermented dairy products must be considered. Lastly, the potential exists for the development of resistant microbial strains. This potential should be reduced by the simultaneous production of multiple antibacterial proteins. Transgenic mice producing lysostaphin in milk represent a proof of concept for the generation of mastitis resistant transgenic cows. Additional proteins will be needed to prevent coliform and streptococcal mastitis.

Key Words: Lysostaphin, Milk

236 Immunogenomics and the periparturient dairy cow: letting leukocytes tell us their own story about disease susceptibility. J.L. Burton*[1], [1]*Michigan State University.*

Despite rigorous management practices aimed at environmental cleanliness, good nutrition, and even vaccination, mastitis remains a problem in periparturient dairy cows. This is partly due to well-known leukocyte dysfunctions that occur during periparturition and jeopardize immune defenses against mastitis-causing organisms. To better understand and control mastitis susceptibility in periparturient cows we need detailed understanding of the genes that regulate and orchestrate leukocyte development, trafficking, and immune defense against the bacteria that infected mammary glands and cause mastitis. We have begun to use combinations of DDRT-PCR, cDNA dot blots, and cDNA microarrays

to identify these genes in leukocytes. Using these techniques we have simultaneously monitored from a few to hundreds of expressed leukocyte genes for differential expression patterns during mid-lactation and periparturition. In this way, we have allowed the leukocytes to tell us their own story about disease susceptibility during periparturition by displaying and quantifying changes in global gene expression patterns. Further physiological studies of interesting differentially expressed genes will help us gain new knowledge about the behavior of gene expression during interesting scenarios such as parturition, intramammary infection, vaccination, and genetic selection. Results of these studies to date will be presented. It is hoped that the new knowledge generated from our work will enable targeted nutritional and drug studies focused on development of novel immunomodulators and mastitis preventatives and therapeutics for periparturient dairy cows. Identified genes will also be studied in our laboratory for the presence of harmful and beneficial mutations that could be taken advantage of using traditional genetic selection to improve mastitis resistance. If highly beneficial genes and alleles are identified, these could be used in the future to develop lines of transgenic cows whose mammary glands have been programmed to specifically target and eliminate intramammary infections. These genetic approaches to bolster immunocompetence should help us counteract any negative effects of selection for high milk yield on mammary immunity

Key Words: Functional Genomics, Periparturition, Mastitis

237 Genetics and Genomics of Susceptibility to Mycobacterial Infection in Cattle. P.M. Coussens*[1], B. Tooker[1], W. Nobis[1], and M.J. Coussens[1], *Michigan State University, East Lansing, MI 48824.*

The Mycobacteria are responsible for significant diseases in man and most animals. In cattle, Mycobacteria are responsible for Johne's disease (M. paratuberculosis) and bovine tuberculosis (M. bovis). As obligate intracellular bacteria, the Mycobacteria have devised ways of surviving in macrophages, one of the animals first lines of defense against such infections. The ability to survive in this hostile environment is a key step in the pathogenesis of Mycobacterial diseases. We have begun studies aimed at understanding interactions of Mycobacteria with the bovine macrophage, using both genetic and genomic tools. Clues from studies in mice and humans have been used to highlight possible genetic elements controlling susceptibility to Mycobacterial infection and to examine various bovine populations for genetic differences in these elements. One such element is the NRAMP 1 gene. In mice the NRAMP 1 gene is directly linked to susceptibility to infection by intracellular Mycobacteria. To evaluate potential roles of NRAMP 1 mutations in the outcome of mycobacterial infections in cattle, we have searched for polymorphisms within the bovine NRAMP 1 coding sequence and analyzed the bovine NRAMP 1 gene structure. These studies suggest that the NRAMP 1 gene is polymorphic in cattle and open the way for analysis of linkage to susceptibility to Mycobacterial infection. To better understand Mycobacterial survival in bovine macrophages, we have applied the tools of functional genomics, using a combination of DD RT-PCR and cDNA microarrays to identify key genes whose expression is altered upon macrophage uptake of Mycobacteria. Gene expression patterns have been cataloged into those genes whose expression is affected by the general process of phagocytosis and those genes whose expression appears to be specifically altered by uptake of Mycobacteria. Differentially expressed genes are then classified according the deduced function or pathway to which their protein products belong. By this process, we hope to elucidate particular pathways within the normal course of macrophage activation that are adversely affected by Mycobacteria. Results of these studies to date will be presented and discussed.

Key Words: Functional Genomics, Mycobacteria, Johne's disease

Latest Development in On-Farm Ultrafiltration

238 Latest Development in On-Farm Ultrafiltration 1. History of On-Farm Ultrafiltration of Milk. John Bruhn*[1], [1]*University of California, Davis.*

Research in the use of membrane processing of milk started in the early 1970's when dairy researchers saw a potential for this technology that was being used to make potable water from saltwater. At that time, the concentration of milk was possible, but problems with fouling, flux rates and difficulties with cleaning and sanitizing of the membrane kept it from being used in the dairy industry. In the early 1980's, the on farm use of reverse osmosis was explored. The farm milk was pasteurized before concentrating in a single pass unit. When the cheese plant received this concentrated milk, it was again pasteurized. The double pasteurization decreased cheese yields, but the on farm process was shown to work. In the 1990's, the on farm membrane processing was installed with a dairy producer cooperative in New Mexico. The concentrating process was evaluated extensively before the regulatory agencies would approve the use in grade A dairy foods. Research established that the concentrating process did not convey any special resistance to the pathogens in the raw milk to standard pasteurization. Nor did pathogens grow faster in the raw milk concentrate. No special resistances or growth advantages were noted. The operating parameters were also defined by the regulatory agencies. With the approval of the regulatory agencies, the membrane concentrated, raw milk became a marketplace reality. The raw milk concentrate is used to fortify solids in milk for cheese making. It also has application in the manufacture of frozen dairy desserts. It has potential for use in any dairy foods where a high quality, milk solid concentarte is needed. Potentially, it also could be used to make a grade A fluid milk product with the addition of water. The advantages of the raw milk concentrate to the dairy and food processor are just being realized.

Key Words: UF, RO

239 Regulatory Issues: Processing and Quality. Alfred Reeb, *New Mexico Department of Agriculture.*

Approximately 20 years ago, the dairy industry first proposed the on-farm ultrafiltration of milk. Initially, the regulatory concerns about the quality of raw milk, temperature of processing, and other processing conditions limited ultrafiltration of milk products to in-plant usage. When on-farm ultrafiltration of unpasteurized milk was proposed in 1994, regulatory concerns about processing conditions and product quality were again expressed. The dairies, the membrane equipment supplier, and regulatory agencies worked together to arrive at an answer for the concerns on the processing conditions of the on-farm ultrafiltration and product quality of the retentate. These regulatory issues concerning the On-Farm Ultrafiltration of Unpasteurized Milk will be addressed in this presentation. Proper design of the Grade A Dairy Plant for Ultrafiltration of the milk was required. The review of the equipment included the monitoring and recording of the temperature of ultrafiltration processing. If the temperature during the ultrafilitration process was greater than 8 °C (45 °F), product was diverted through a flow diversion valve. Testing of equipment and the placement of regulatory seals will be discussed. Bacteriological quality of unpastuerized milk for concentration and unfiltered milk is in compliance with the Grade A Standard. Conformance of this concentrated product to Grade A Standards will be also discussed.

Key Words: Regulatory Issues, Quality of Unpasteurized UF Milk, Processing

240 Applications of membrane filtered cold milk as an ingredient. P. Tong*[1] and H. Vyas[1], [1]*Dairy Products Technology Center, California Polytechnic State University, San Luis Obispo.*

Membrane processing of milk at low temperatures results in a concentrated and/or fractionated milk stream which has been obtained with little to no heating. Such concentrates can then be delivered to an ingredient user and only heat processed once to obtain the final pasteurized product. As a result, any undesirable changes associated with heat processing (e.g., protein denaturation, cooked flavors, etc.) can be minimized. When ultrafiltration membranes are used, modification in protein to lactose ratios, and mineral composition of the concentrate are possible. Therefore, such membrane processed milk concentrates will be desirable as ingredients for cheese manufacture, ice cream manufacture and specialized dairy based beverages and other foods. Use of these ingredients may improve finished product composition control (standardization to more optimum protein to fat or protein to lactose ratios), plant throughput/efficiency, and product overall quality (flavor, texture, etc.).

Key Words: ultrafiltration, membrane, milk