to identify these genes in leukocytes. Using these techniques we have 
simultaneously monitored from a few to hundreds of expressed leuko-
cyte 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 infec-
tion, 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 dietary studies focused on 
development of novel immunomodulators and mastitis preventative 
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 ge-
etic approaches to bolster immunocompetence should help us counter-
act 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 My-
cobacterial Infection in Cattle. P.M. Coussens*1, B. Tooker1, 
W. Nobis1, and M.J. Coussens2, Michigan State University, East Lans-
ing, MI 48824.

The Mycobacteria are responsible for significant diseases in man and 
most animals. In cattle, Mycobacteria are responsible for Johne’s dis-
ease (M. paratuberculosis) and bovine tuberculosis (M. bovis). As obli-
gate intracellular bacteria, the Mycobacteria have devised ways of sur-
viving 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 ge-
etic 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 My-
cobacteria. To evaluate potential roles of NRAMP 1 mutations in the 
outcome of mycobacterial infections in cattle, we have searched for poly-
morphisms 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 under-
stand 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. Differen-
tially 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. Re-
sults 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 salt water. 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 be-
fore concentrating in a single pass unit. When the cheese plant received 
this concentrated milk, it was again pasteurized. The double pasteur-
ization 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 concen-
trating 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 advan-
tages 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 mak-
ing. 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 
produced concentrate is needed. Potentially, it also could be used to make 
gamma 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. Al-
fred 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, reg-
ulatory 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 con-
cerns 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 Ultrafiltra-
tion of the milk was required. The review of the equipment included the 
monitoring and recording of the temperature of ultrafiltration process-
ing. If the temperature during the ultrafiltration 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 dis-
cussed. Bacteriological quality of unpasteurized milk for concentration 
and unfiltered milk is in compliance with the Grade A Standard. Con-
formance of this concentrated product to Grade A Standards will be also 
discussed.

Key Words: Regulatory Issues, Quality of Unpasteurized UF Milk, Pro-
cessing

240  Applications of membrane filtered cold milk as an 
ingredient. P. Tong*1 and H. Vyas1, 1 Dairy Products Technology 
Center, California Polytechnic State University, San Luis Obispo.

Membrane processing of milk at low temperatures results in a concen-
trated 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 pas-
teurized 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 manu-
facture 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