

# CALIFORNIA Dairy Dispatch

RESEARCH, EDUCATION AND SERVICE TO SUPPORT THE DAIRY INDUSTRY

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## International scientists use genomics to unwrap the goodness of milk

By Jennifer Giambroni

The science of milk, lactation, nutrition and genetics came together this September at the 3rd International Symposium on Milk Genomics and Human Health in Brussels, Belgium. The three-day event, organized by the California Dairy Research Foundation (CDRF) and the International Dairy Federation (IDF), featured current developments in research utilizing the tools of genomics to understand milk and its health properties.

Presented by the International Milk Genomics Consortium (IMGC), the annual event is based on the scientific principle that milk is the only biological product that is the direct result of continuous Darwinian selective pressure to provide nutrition and improve the health of mammals. Lactation evolved over millions of years to produce ingredients that provide infants with a greater probability of health and survival. The critical biological strategies that emerged from this evolutionary process are encoded within the genomes of mammals.

The field of genomics provides new opportunities to understand

(see **Genomics** on page 2)



From left, Christian Robert, director general of IDF, Joe O'Donnell, executive director of CDRF, and Bruce German, UC Davis.

## San Francisco symposium to highlight the latest trends in value-added dairy ingredients

The Ninth Annual Dairy Ingredients Symposium and Third International Spray Dried Milk Conference will be held February 26–28 at the Sir Francis Drake Hotel in San Francisco. Dairy ingredients marketers and manufacturers, food industry professionals who buy or use dairy ingredients and want to maximize their value are encouraged to attend.

Presenters will discuss the latest trends in the marketing, science, manufacturing technology and food applications of dairy ingredients that are affecting current and future work responsibilities. Experts in academia, government and the dairy industry will provide information on key developments in dairy ingredients that

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the role each component of milk plays in overall health by studying its genetic origins. Bruce German, a professor at the University of California, Davis (UC Davis), and scientific chair of the IMGIC, said, "With the human genome sequenced and many other genomes following, the genes responsible for milk production can guide scientific research into the molecules, functions and health benefits contained in milk's diverse components."

The first milk genomics symposium in 2004 focused on the study of lactation genomics for nutrition. The

second event provided a pathway to move forward as a global consortium. This year's event concentrated on recent scientific breakthroughs and created a strategic direction for moving these into practice.

Symposium presentations included results obtained by analyzing the oligosaccharides present in human milk and their selective stimulation of specific intestinal bacteria. Carlito Lebrilla, a professor at UC Davis, presented state-of-the-art mass spectrometry and how these new analytical techniques can revolutionize the understanding of the structures of milk oligosaccharides. Analytical strategies have been developed to quantify these molecules in complex mixtures making it possible to rapidly define many of their biological functions.

UC Davis Professor David Mills stated that most bacteria, including intestinal pathogens, are unable to use these complex sugar structures as food sources; however, bifidobacteria infantis, a strain obtained from a breast-fed infant, grew successfully solely on these molecules as a carbon source (see related genomics article on page 7).

Kevin Nicholas of the University of Melbourne conducted research on a wide variety of mammals and marsupials identifying alpha lactalbumin as a potential apoptotic regulator during involution of mammary tissue. Catharina Svanborg of Lund University in Sweden presented research on the ability of an intermediate of alpha lactalbumin, HAMLET, to promote the death of transformed cells culminating in a demonstration of the elimination of tumor cells in bladder cancer in humans. Clemens Kunz of Germany's Giessen University provided a summary of human and animal milk oligosaccharides focusing on potential influence of specific oligosaccharide patterns within the intestinal tract.

Itamar Barash of the Volcani Center in Israel, discussed the regulation of milk protein in the mammary

gland; Patrice Martin of the Institut National de la Recherche Agronomique (INRA) in France demonstrated how genetic polymorphisms may modulate the protein fraction of milk by affecting different cellular processes; Daniel Tomé of the INRA described how a modification of milk protein composition could improve their effect on energy metabolism; Pasquali Ferranti of the University of Napoli in Italy spoke about milk genomics and proteomics; Sylvain Bellier of the INRA highlighted an integrative approach to using genomics and proteomics to identify intestinotropic properties in the milk of mice; Kay-Uwe Wagner of the University of Nebraska Medical Center focused on the transcriptional control of normal mammary function; and Johan van Arendonk of the Wageningen Institute of Animal Sciences presented information from the Dutch Milk Genomic Initiative, which is working to identify genes that contribute to natural genetic variation in milk quality traits—milkfat and milk protein composition.

The Symposium also spotlighted the importance of IMGIC's Web Portal ([www.imgiconsortium.org](http://www.imgiconsortium.org)) as the interface through which scientists can work with databanks that are becoming the standard information resource of modern life science. Event sponsors included CNEIL, DairyAustralia, Dairy Farmers of Canada, MeadJohnson Nutritionals, The Dutch Dairy Association and Teagasc. The symposium attracted attendance from 24 countries, including Australia, Belgium, Canada, Denmark, France, Germany, Hungary, Ireland, Italy, The Netherlands, New Zealand and the U.S.

A fourth International Symposium on Milk Genomics & Human Health is scheduled for November 7-9, 2007, in Napa, CA, and will be coordinated by the CDRF. Details will be available online in late 2006. For more information, contact coordinator Jennifer Giambroni at (415) 254-4549, or [info@imgiconsortium.org](mailto:info@imgiconsortium.org).



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## CDRF's most recent Nutrition and Health projects

The following CDRF projects seek to obtain more information about dairy components and probiotics. Eric Gershwin's project looks at whether whey protein can enhance protection of the immune system in elderly patients against influenza virus. Dan O'Sullivan's project uses a genomics approach to develop knowledge to maximize the survival and activity of probiotic cultures in dairy products during processing and distribution. James Steele's project seeks to determine the advantages of fermented dairy products as a delivery vehicle to deliver the health benefits of probiotic cultures to consumers as compared to other methods such as dried cultures.

### CDRF – Extending Dairy Dollars

The California Dairy Research Foundation's (CDRF) mission is to promote research and development activities that benefit California's dairy producers, processors, and consumers by increasing the value of milk and dairy products. In order to maximize the investment of California's dairy industry and ensure that projects are relevant and applicable to industry needs, the CDRF actively solicits co-funding from a number of industry and government/academic sources. As a result, for every \$1 invested, at least another \$1 in funding is provided through co-funding sources. Additionally, by working with land-grant universities, indirect costs such as researcher salaries, lab facilities and other overhead expenses are included in each project – thus extending project co-funding to a ratio of \$2 co-funded for every \$1 funded by CDRF.

In addition to industry partnerships, the CDRF co-funding sources include state and federal grants as well as programs such as the California State University Agriculture Research Initiative (CSU/ARI) and the UC Discovery Grant program.

#### CSU/ARI

The California State University Agriculture Research Initiative (CSU/ARI) provides new avenues of opportunity for the CSU to leverage existing faculty and staff talent while attracting matching funds for applied agricultural and natural resources research.

#### UC Discovery Grants

The Industry-University Cooperative Research Program (IUCRP) awards MICRO Grants and UC Discovery Grants in five fields of science and engineering, including information technology for life sciences such as agriculture and animal sciences and veterinary medicine. UC Discovery Grants form a 3-way partnership between the UC, industry sponsors, and the State of California for up to four years of funding.

#### Dr. Eric Gershwin— 06 Gee-01 NH

*The Effect of Milk Component Supplementation on the Response to the Pneumonia Vaccine in Sr. Citizens: A Randomized, Placebo-controlled pilot study*

5/15/2006–5/14/2007

#### Objective:

Test the ability of whey protein to improve the performance of the pneumonia vaccine in elderly patients by naturally enhancing their immune system through dietary components from milk.

#### Dr. Dan O'Sullivan— 06 SUD-01 NH

*Enhanced Stress Resistance of Bifidobacteria in Yogurt*

5/1/2006–4/30/2008

#### Objectives:

1. Identify gene sets that are switched on over time when bifidobacteria are transferred from a neutral pH environment to a yogurt environment.
2. Identify an inducer or inducers that can switch on the different gene sets prior to transfer to yogurt.
3. Test the effectiveness of the pre-treatments on different bifidobacteria that are used as probiotics.
4. Identify genes important for probiotic functionality that are induced during yogurt manufacture and storage.



#### Dr. James Steele—

#### 06 STJ-01-NH Phase 1

*Phase 1: Substantiating Advantages of Fermented Milks as Delivery Vehicles for Bifidobacterium*

10/1/2005–12/1/2006

#### Objectives:

1. Compare survival of *B. lactis* propagated in milk as monoculture and in combination with yogurt cultures vs those propagated in lab media when challenged with gastric and duodenal juices
2. Compare *S. thermophilus* and *L. delbrueckii* as described above.

# Figuring out the lactose puzzle

By Joseph O'Donnell

**B**lond, sweet and amply proportioned—I'm talking about lactose, of course. Lactose is a well-known ingredient. As the most abundant solid in milk, much of commercial lactose finds its way into everything from pharmaceuticals to animal feed. The main constraint on lactose as a food ingredient is competition from low-priced corn syrup. There are distinctions that lactose holds over the competition with low hydrophilicity, low sweetness level and lower digestibility (which can be a negative for those with lactose malabsorption) just being a few.



While I'm not suggesting that lactose could beat the price of corn syrup any time soon, it is an interesting exercise to explore expanding markets by figuring out the puzzle nature threw at us. Why is it that nearly the entire plant world of carbohydrates (and even the storage form of carbohydrates in animals) is based on glucose and/or fructose polymers, yet milk comes up with this unique disaccharide—lactose? When we answer that question, we can delve into a plethora of new marketing and product development opportunities.

Milk is the original slow food. Casein hits the stomach acid and forms clumps, making it harder for the proteases to break it down. Milkfat is in globules with a protective protein coating, and the saturated fat content so widely criticized actually slows digestion. The lactose depends on the presence of limited lactase for digestion, but the bottom line is that milk is digested at a rate consistent with the need to deliver nutrients.

Lactose as a slow food is a good argument for explaining how evolutionary pressure came up with this sugar. Lactose requires lactase to be digested and absorbed, and with only modest levels of lactase available, the lactose

cruises throughout the length of the small intestine, gradually releasing simple sugars at rates the rest of the body can assimilate. Some of this lactose also may escape to the colon. Isn't this a definition of fiber—a carbohydrate resisting complete degradation in the small intestine and presenting itself to the bacteria-laden colon?

Here's where we put on our probiotics hat. Lactobacillus probiotics tend to reside in the small intestine at modest levels. Bifidobacteria probiotics hang out in the colon. We might not know the full benefits of these probiotics but we are gaining considerable insight. So, lactose comes along feeding the lactobacillus in the small intestine and continues down to jump into the colon to feed the bifidobacteria. Evolution has constructed a carbohydrate that delivers metered energy to the body, energy to selected bacteria in the small intestine and energy (ala fiber) to selected bacteria in the colon.

With the original consumer being a baby with a sterile gastrointestinal tract, this means that the bugs that do set up housekeeping are those that can utilize lactose. Now, if all this is indeed fact, then we should see evidence in the mammalian genome, specifically in the human genome, which has been sequenced and is under intense scientific investigation.

Currently adult nutrition is compromised by the consumption of highly refined and easily digestible and available foods that deliver a slug of nutrients to trigger an insulinogenic, anabolic response under crises conditions. Constant nutritional insults of this sort lead to breakdowns and chronic diseases. Foods can be reformulated to regain the slow food approach and, no doubt, lactose can be part of that solution. At the same time, a slow food approach should be able to reduce lactose malabsorption, which has as much to do with the rate of digestion as with the level of lactase in the body.

While lactose might not have a direct effect on immune activity, immune activity could be the indirect consequence of lactose's biological (prebiotic) activity. We could brainstorm all day long on this and other scenarios of lactose bioactivity. At the end of the day, however, we know that the best and brightest of our dairy scientists are actively pursuing this area. Bit by bit we will solve the lactose puzzle to the benefit of the industry and consumers.

*This article was excerpted from an article that appeared in the October 13, 2006, issue of Cheese Market News.*

## AAP recommends lactose-intolerant children consume some dairy products

According to a new report from the American Academy of Pediatrics (AAP), children who are lactose intolerant should continue to eat some dairy foods to maintain recommended daily levels of calcium and vitamin D.

Lactose intolerance can cause abdominal pain, diarrhea, nausea, bloating, flatulence, and other digestive discomfort; diminish quality of life; and decrease attendance in school, leisure and sports activities.

The AAP report, "Lactose Intolerance in Infants, Children and Adolescents," also says pediatricians should consider age and ethnicity when diagnosing a child with this condition.

More than 70 percent of the world's population has a lactase deficiency, although it is disproportionately found in populations with non-dairy diets, including Asian and Native American (nearly 100 percent), Hispanic (80 percent), black (60 to 80 percent) and Ashkenazi Jewish (60 to 80 percent). Only 2 percent of European populations are lactose intolerant.



Children in a high-risk ethnic group for lactose intolerance may develop symptoms as early as age 2 or 3; Caucasian children, no earlier than age 4 or 5. Lactose intolerance is rarely found in children younger than age 2 or 3, and such symptoms before age 2 may indicate another condition, such as an acute infection or bowel injury, requiring further testing.

As calcium is important for bone mineralization and essential for child growth, the report does not rec-

ommend eliminating dairy products to treat lactose intolerance. Children should continue to include calcium and/or non-dairy foods containing calcium and vitamin D in their diets to get their recommended daily levels. Yogurts and cheeses may be better tolerated than regular milk, and along with lactose-free milk, can provide alternative sources of calcium.

*This report appeared in the September issue of Pediatrics, a scientific journal of the American Academy of Pediatrics (AAP).*

## Secret found to long-life yogurt

New Zealand dairy group Fonterra has discovered a new manufacturing process that can increase the shelf-life of yogurt to up to 90 days by killing spoilage yeast and mold, while selectively preserving live and active cultures, including probiotic bacteria.

The worldwide yogurt market has grown over 8 percent annually for the past three decades, with 58 percent of the growth occurring in the past five years alone. The demand is being driven by the perceived nutritional and dietary benefits of yogurt.

However, processors must strike a balance between using the traditional heat treatment methods used in creating long-life yogurt and the resulting kill-off of the live and active culture that gives yogurt many of its potential health benefits.

The new process retains the fresh characteristics of the product with no compromise to flavor, color or nutritional characteristics, Fonterra stated. Manufacturers who currently make heat-treated long-life yogurt could instead use this process to retain live and active cultures.

The new process is natural, uses no additives or preservatives, and can be used on a variety of cultured foods and beverages. Further, the technology does not require significant disruption to existing manufacturing processes and existing formulation and packaging can be used in most cases.

Yogurt manufactured using the process meets the Codex international standard of identity regarding minimal levels of live and active cultures, allowing it to be labeled and sold as fresh yogurt.

*This was excerpted from an article by Ahmed ElAmin that appeared in the September 28 issue of DairyReporter.com.*

## Study reveals cooling tunnels help hot cows to up milk yield

**C**ows cooled by an evaporative tunnel produced more milk and ate up to 12 percent more feed than those placed merely in shade or under sprinklers, says a U.S.-based study published in October's *Journal of Dairy Science*. The findings could be important for dairy firms around the world as they look to increase profitability and efficiency.

"The advantage of evaporative tunnel ventilation became more dramatic as temperatures increased," said the study's co-author Terry Smith of Mississippi State University. He said the technology was less effective in higher humidity, but still better than fans or sprinklers.

New, large-scale facilities incorporating a cooling tunnel system are around 20-25 percent more expensive than facilities using sprinklers or fans.

"But, as producers will tell you, the increased cost can be rapidly returned in regions with severe heat stress through sustained milk production and better reproductive efficiency during the period of heat stress and beyond," said Smith. He added that a more limited cooling tunnel system could be added to existing facilities on farms "at a fraction of the cost of a new barn."

Early results from additional studies on cooling tunnel technology show it may be beneficial for cow nutrition, fertility and air quality. The results are still being analyzed.

*This was excerpted from an article by Chris Mercer that appeared in the September 19 issue of DairyReporter.com.*

## A little wedge'll do ya

**N**ew information that has come to light about the benefits of eating dairy has helped improve cheese's image, including the news that the calcium and other nutrients in it can help the body burn fat as well as reduce the risk of diabetes and heart disease.

"Cheese is a great food choice," said Dr. Michael Zemel, director of the University of Tennessee Nutrition Institute, where he conducted the ground-breaking and much talked about studies observing dairy and fat burning. "But calories still count if you're trying to lose or maintain weight."

Zemel explained the dairy dieting connection: "When your body doesn't have enough calcium, it mounts a hor-

monal response that tells the body 'Let me hold onto whatever calcium I can.' You release calcitriol, which turns on the molecular machinery for making fat from sugars, and inhibits the biochemical machinery involved in fat breakdown. It interferes with a process called programmed cell death, where we naturally get rid of the oldest most fat-filled cells. So, on a low-calcium diet, you make more fat, break down less fat, and have bigger, fatter fat cells."



He said that when we consume plenty of calcium from dairy, calcitriol production is suppressed and weight loss is encouraged. "In clinical trials, we found that people who cut calories and were on a dairy-rich diet lost nearly twice as much weight as those who cut calories but were on a low-calcium diet," Zemel said, adding that the best results occurred when the calcium came from servings of dairy, rather than calcium supplements.

"They lost twice as much fat, and most of that fat came from the midsections of their bodies," said Zemel. "That's great from both a cosmetic standpoint and a health standpoint, because that's where the most dangerous fat is—the fat associated with diabetes and heart disease."

If you're on a weight-loss diet, you want the most calcium for the least calories. An eight-ounce yogurt will give you about 300 to 400 milligrams of calcium. To get that much from cheese, you would have to eat hunks of it, and that's not going to help you lose weight.

However, NYU nutrition expert Lisa Young said, "If you crave cheese, do yourself a favor and eat a real piece of cheese. Cut yourself a sliver of Brie, or whatever kind you like, eat it and enjoy it. Otherwise, if you substitute with low-fat or no-fat cheese, you're going to eat much more. And still crave the Brie."

*This was excerpted from an article by Sari Botton that appeared in the May 10, 2006, issue of Newsday.com.*

# Genomic comparison of lactic acid bacteria published

*Zesty microbes enliven the palate, provide better blueprint for biofuels and specialty chemical production*

**W**ith public concerns at a fevered pitch over the bacterial contamination of spinach, it is easy to lose track of how bland and deprived our world would be without the contribution to our food supply of such benign microbial players as lactic acid-producing bacteria. Researchers from the U.S. Department of Energy Joint Genome Institute (DOE JGI) and the University of California, Davis, and their colleagues have characterized the genome sequences of nine different lactic acid-producing bacteria, or LAB, and have published their findings in the October 17 edition of the Proceedings of the National Academy of Sciences. The small LAB genomes encode a diverse repertoire of genes for efficient carbon and nitrogen acquisition from the nutritionally rich environments they inhabit and reflect a limited range of biosynthetic capabilities promising broad industrial applications.

Lactic acid-producing bacteria play a key role in the production of fermented foods and beverages, accounting for tens of billions of dollars in sales annually. Products constituting a fine repast, such as wine, salami, cheese, sourdough bread, pickles, yogurt, cocoa and coffee are all enhanced by LAB, which ferment six-carbon sugars, or hexoses, to produce lactic acid.

“DOE JGI’s contribution to the whole study of lactic acid bacteria is simply immense,” said David Mills, associate professor of viticulture and enology at UC Davis, and senior author on the study. “Access to the genome sequences for these fermentative microorganisms will dramatically increase our understanding of their role in industrial food production, leading to more optimized production schemes. For example, a better

understanding of the role of lactic acid bacteria in cheese ripening will result in production strategies that reduce ripening time and thereby save energy. Moreover, lactic acid bacteria are used for production of various commercial bioproducts such as dextran and antimicrobials. The availability of these genome sequences will foster development of additional production schemes for biofuels and other important chemicals.”



The publication is the culmination of a multiyear effort by the Lactic Acid Bacteria Genome Consortium, a group of at least a dozen academic organizations formed in 2001. Paul Richardson, DOE JGI Genomic Technologies Program head, said that the functional classification embraced a variety of industrially important genera, including *Lactococcus*, *Enterococcus*, *Oenococcus*, *Pediococcus*, *Streptococcus*, *Leuconostoc*, and *Lactobacillus* species. “The sequence of these diverse species offered a window into the sugar metabolism and energy conversion systems of LAB, and the evolution of

these systems, which helped identify key enzymes involved in the production of end products including acetic acid, lactic acid, ethanol, and CO<sub>2</sub>.”

“This work represents a hallmark in the genomic and bioinformatic characterization of lactic acid bacteria that have an impact on food, health, and agriculture,” said Willem M. de Vos, professor of microbiology and program director of the Wageningen Center for Food Sciences in Holland. “In a heroic effort, their publication more than doubles the number of lactic acid bacterial genomes that are publicly available and provides the research community with a wealth of high-quality data that can be used to understand and improve starter cultures for dairy, meat and wine fermentations; probiotic cultures; and other industrial applications. The extensive bioinformatic analyses by world experts adds to the impact of the genomic data and provides new hypotheses on how microbial genomes evolve by mechanisms of genomic loss and horizontal gene acquisitions.”

The DOE Joint Genome Institute, supported by the DOE Office of Science, unites the expertise of five DOE national laboratories, Lawrence Berkeley, Lawrence Livermore, Los Alamos, Oak Ridge, and Pacific Northwest, along with the Stanford Human Genome Center to advance genomics in support of the DOE missions related to clean energy generation and environmental characterization and clean-up. DOE JGI’s Walnut Creek, Calif. Production Genomics Facility provides integrated high-throughput sequencing and computational analysis that enable systems-based scientific approaches to these challenges.

For more information, contact David Gilbert, DOE JGI Public Affairs Manager (925) 296-5643, gilbert21@llnl.gov.

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## *Calendar* of **EVENTS**

### **January 23-26, 2007**

**8th Annual Frozen Dairy Desserts Manufacturing Short Course.** Course will emphasize ingredients function and usage, mix formulation, equipment and processes in frozen dessert manufacture. Location: Cal Poly Dairy Products Technology Center, San Luis Obispo, CA. For information, visit [www.calpoly.edu/~dptc](http://www.calpoly.edu/~dptc).

### **February 26-28, 2007**

**9th Annual Dairy Ingredients Symposium & 3rd International Spray Dried Milk Conference.** See article on page 1. Location: Sir Francis Drake Hotel, San Francisco

### **March 20-23, 2007**

**19th Annual Cheese Short Course I.** Designed to teach each participant the basic scientific information and practical skills needed to understand and manufacture cheese. (includes one day of hands-on cheese making). Location: Cal Poly Dairy Products Technology Center, San Luis Obispo, CA. For information, visit [www.calpoly.edu/~dptc](http://www.calpoly.edu/~dptc).

### **April 17-18, 2007**

**12th Annual Milk Processing Technology Short Course.** Course emphasizes principles and technology for the processing of milk for fluid and manufactured dairy foods. Location: Cal Poly Dairy Products Technology Center, San Luis Obispo, CA. For information, visit [www.calpoly.edu/~dptc](http://www.calpoly.edu/~dptc).

### **Dairy Ingredients** *from page 1*

can affect decisions on manufacturing technology, quality management, marketing strategy, product development, and business development.

This year's Ingredients Symposium program is being co-organized by Cal Poly's Dairy Products Technology Center and Dairy Management Inc., as a joint meeting incorporating the Third International Spray Dried Milk Conference.

Discussion topics will include:

- Latest developments in technology for the manufacture of concentrated and dried milk and whey derived products
- New approaches to characterization of dairy ingredients
- Factors affecting the composition, sensory and functional properties of dairy ingredients
- Interactions of dairy ingredients with other food components and their implications
- Challenges and opportunities for innovative uses of dairy ingredients
- How emerging marketing and economic trends favor dairy ingredients

For more information on and to register for the Ninth Annual Dairy Ingredients Symposium and Third International Spray Dried Milk Conference, visit [www.calpoly.edu/~dptc/symp07.html](http://www.calpoly.edu/~dptc/symp07.html). For more information on formulating and innovating with dairy ingredients, visit [www.innovatewithdairy.com](http://www.innovatewithdairy.com).