

GUEST COLUMNIST



Perspective: Industry Innovation

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Unraveling the secret of milk's nutrition

When Watson and Crick defined the structure of DNA in 1953, James Watson (American) reputedly boasted, "We have found the secret of life." More than a half a century later we are still grappling with this "secret" and how we can use it to improve human health.

Along the way, science has grown from understanding the chemical structure of the "secret of life" polymer, deoxyribonucleic acid (DNA), to understanding more about the organization of DNA into units called genes. The genes collectively are called the genome of the living thing from which they originated.

This level of discovery requires constantly evolving analytical technology. Instead of painstakingly running experiments in test tubes, many analyses are done automatically and rapidly around the clock. When science finally arrived at the position where it could conceive of sequencing the human genome (identifying the sequence of the two base pairs that make up the polymer of our DNA), it took less than two decades and produced technology that helped advance the field of genomics exponentially.

The release of the human genome in 2003 opened a new area of discovery and the field exploded with scientists throughout the world eager to apply this knowledge to other species—including the bovine. After all, human civilization is closely linked to the humble cow. It is used around the world to supply draft labor, meat and milk and has been an essential part of our survival since we first domesticated cattle more than 9,000 years ago.

The same year the human genome was unveiled, a global effort involving 300 scientists and \$50 million was launched to map the bovine but it was lacking in one important fundamental area — looking closely at bovine lactation genes. It took the support of California dairy producers and an alert scientific community to generate information essential to the heart of the dairy industry — what genes are responsible for the nutritional package that is milk?

When the bovine genome project was underway, researchers conducting genomics-based milk bioactives

projects at UC Davis became aware of the lack of lactation focus and proposed working on a concurrent project to do a milk-specific analysis of the bovine genome. Led by UC Davis, this group effort involved a team of researchers from throughout the world, including Simon Fraser University, University of Colorado Denver, Michigan State University, University of Geneva Medical School, CSIRO Livestock Industries, University of California Santa Cruz, AgResearch, University of California San Francisco, Swiss Institute of Bioinformatics, Imperial College London, Nestlé Research Centre and Baylor College of Medicine. The resulting paper was published in *Genome Biology* on the same day the main bovine genome papers appeared in *Science*, with additional commentary specific to the milk genome appearing in the *Journal of Nutrition* the following week.

Now we get to the good stuff. With the basics in place, scientists around the world can and will accelerate their work on animal health, muscle development, milk production (quantity and composition), reproduction, efficiency of conversion of forage to milk and meat, reduction of greenhouse gas production — the list is infinite.

The real bottom line in all of this is creating a healthier world as the products of our domesticated bovines deliver unmatched nutrition to a global population. U.S. dairy cows will become more efficient, more sustainable, more environmentally friendly and healthier and the products, especially milk, they produce will be tailored to deliver specific benefits to human consumers. All food producers use breeding techniques to try to build health advantages to the humans who consume their products. Milk enjoys the distinct advantage of an ancient association with humans and a common physiological process, lactation. Sorting out the means to convert bovine milk to be more human-like is not insurmountable. This strategy will

occupy scientists' attention for many years to come.

Bovine genomics work hasn't remained idle while the genome was being mapped. Researchers have been investigating a number of milk components, including oligosaccharides (OS) — short polymers of lactose-based sugars found in human and bovine milk. These milk components are not digestible which begs the question as to why the mother would invest energy and material into their production. The answer appears to be that these OS guide the colonization of appropriate healthy bacteria in the gastrointestinal tract of the newborn. Imagine the response from the infant formula or geriatric food industries to a commercial supply of biologically-active OS. Bringing the genetics of the bovine closer to producing milk resembling human milk in composition could create endless new marketing opportunities for dairy.

Much of this information can be found on the International Milk Genomics Consortium (IMGC) web portal: www.milkgenomics.org. This site contains the references to all the papers listed above as well as deep insights into where this field is taking us as an industry and as consumers. In September, the IMGC will host the 6th International Symposium on Milk Genomics & Human Health in Paris to share the latest data in this growing field of research.

All dairy products can benefit from milk genomics. Whether it is making tastier cheese or delivering health benefits such as satiety, relief from gastrointestinal distress, improved immune responses or more, the world will continue to become a better place through the partnership of humans and bovines. CMN

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