



Turf and the Biomolecular Revolution

By **Steve Millett**, Department of Plant Pathology, University of Wisconsin—Madison

The year is 2010, and the effects of the biomolecular revolution generated by the University of Wisconsin have spilled over into everyday life. Golf courses are no exception. The Turfgrass Biotechnology Center (TBC) has led the way in the turfgrass arena by generating more than 500 patents in its short five year history. Golf course superintendents are now called Turf Engineers and turfgrass maintenance has never been like this.

One of the best places to view the huge impact of the biomolecu-

lar revolution on golf course maintenance is at the Aldo Leopold Biotech-Hybrid Golf Course and Wildlife Conservatory. The first biotechnology products generated by the TBC were tested at the Leopold Hybrid Course. Back in 1999, this idea from the creative minds at the UW-Madison and the Wisconsin Turfgrass Association was met with skepticism and derision by some. But Oscar Peterson, head architect and Turf Bioengineer of the Leopold Hybrid Course, says, "I think Aldo would

be happy with what we have done here at the Hybrid Course. Leopold, known as the 'Father of Wildlife Conservation,' pioneered the first UW-Madison program in wildlife management in 1933. And here we are, 77 years later with a beautiful golf course and conservatory area that lets humans, biotechnology and wildlife live in harmony."

Peterson, a UW-Madison graduate of the last century, has witnessed many biotechnology advancements in the turfgrass

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industry, including his tinkering with the gene gun. Peterson explains: "I was a little skeptical. Then I saw the 'Rounder-ready' herbicide resistant turfgrass selections at the O.J. Noer Research Facility and was convinced. After having a few Lienies with Chris May, we came up with the idea of the 'Gene Gunner.'

"Our original idea was to assemble several gene guns on the back of a greens mower and use it as a field tool, instead of just a laboratory research tool." Back then, the gene guns were selling for approximately \$17,000, a price tag that was a difficult obstacle to overcome. Oscar and Chris were undeterred. Oscar continues: "After finding out how much the gene guns cost, we thought our dream was crushed. But we convinced the Turf Department to lend us the gene gun for on week."

Chris May, CEO of World Wide Turf, says after reading the gene gun manual, they realized it was nothing more than a high priced toy. Explaining how he and Peterson came up with the Gene Gunner, May says, "Basically, what the gene gun does is air-inject foreign pieces of DNA into another organism's DNA. The procedure is rather simple. First, you find a piece of DNA that you are interested in introducing to your target organism. Oscar and I, of course, chose to introduce Rounder-ready genes to the 10th green of the Leopold Hybrid Course. Our next step was to coat tiny pieces of gold with the Rounder-ready genes, load the gene gun chamber with our DNA gold bullets, and shoot them into the nucleus of the turfgrass cells. Some of the turfgrass cells that were not blown to pieces took up the foreign Rounder-ready gene and began to produce the gene product. We waited one season and then applied Rounder on the area. The turf that had incorporated the gold-blasted Rounder-

ready gene was not killed by the herbicide. The one-inch swath within the killed area had been transformed with our Rounder-ready genes. This was the first field application of the gene gun!"

This experiment garnered little attention because of the impracticality of buying a \$17,000 gene gun. Oscar and Chris went back to the drawing board. They knew this technology could work, but the expense was too high. What they needed was something cheaper and easier to operate.

Chris came up with the ingenious idea of using b.b. guns instead of the gene gun. "The idea actually came about when my son asked for a b.b. gun for Christmas. I remembered, after reading the owner's manual for the gene gun, that Oscar and I joked about it being nothing more than a fancy air-powered b.b. gun. I was in the checkout lane when the adrena-

line almost overpowered me from by brainstorm. When I realized a \$20 b.b. gun was the solution to our problem, I bought every gun Wal-Mart had in stock. I rushed them out to the maintenance facility and by the next morning, Oscar and I had welded ten b.b. guns to the back of a greensmower. Then we transformed the rest of the tenth green."

The dream of Oscar and Chris resulted in a patent and World Wide Turf, makers of the Gene Gunner, soon became Wisconsin's leading Turfgrass Technology Company, now employing more than 1,500 workers in Verona.

Since then, World Wide Turf has joined the Turf Department at the UW-Madison in the quest to transform the newly acquired cold regulated genes - cor genes. The cor genes were first isolated from the snow mold fungus *Typhula ishikariensis* biological



The gene gun that started Wisconsin's turfgrass dominance.

species III. These genes help the fungus stay alive at subzero temperatures by giving it the ability to breakdown stored carbohydrates at suboptimum conditions. When these genes are transformed into turfgrasses, it protects turfgrasses from winter kill and keeps other snow mold pathogens from attacking.

This new technology has grown tremendously these last few years. Shawn Hilliard, World Wide Turf's Gene Gunner salesman, says, "The herbicide genes were the first genes to be transformed into turfgrasses. However, they are not our number one seller anymore. Today, our hot sellers are the Bt (*Bacillus thuringiensis* gene for insect management), chitinase (for antifungal properties) and of course the amenity genes.

"The amenity genes are the most expensive ones, ranging from \$2,000 to \$10,000 per application. The mint and lemon balm essential oil genes are the trendiest and sweetest smelling products I have ever sold. There is nothing like the smell of a freshly mowed lemon balm putting green!"

However, the sense of smell can't compete with World Wide Turf's most bizarre amenity gene: the Luciferase gene. The Luciferase gene is what makes the tail of our summer insect friend, the firefly, glow. It now lights Wisconsin's putting greens at night. The first Firefly Tournament at Blackhawk Country Club (BCC) attracted the world's best golfers and captivated the hearts of golf enthusiasts around the world.

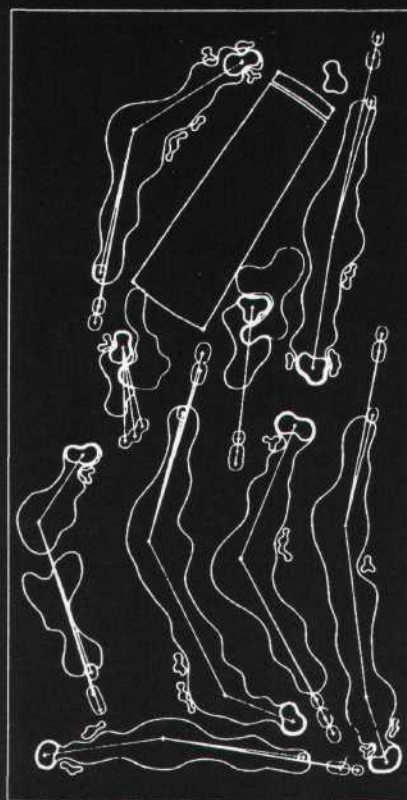
Tiger Woods was impressed with the technology and said, "This technology is going to change the way I golf. I had to use my global position system to find my GPS balls that I lost in the rough. Even though the golf balls glow, they can still be overlooked. Infra-red night goggles can help in setting up your

line, but keeping your balance and sense of positioning definitely comes into play. Teeing off under the stars while crickets sing and fireflies streak across your line of vision is an unforgettable experience. Hopefully, this night course will host a major event in the near future. Is this heaven?"

Although the Luciferase gene has created media hype in the golf world, it has also affected other areas of our life. Monroe Miller, currently the Turf Engineer at BCC, accidentally stumbled onto another application. Monroe explains: "While Dave Noltner and I were loading the Gene Gunner with Luciferase, I inadvertently pulled the trigger while I was holding the end of the gun. I felt the warm, high-pressure air hit my hand. Three days later, I noticed my hand glowing. The doctors at the UW-Madison hospital performed tests on my glowing hand and found nothing to worry about. Today, I received a patent on my Luciferase tattoo idea and will soon be opening up my own body piercing and Luciferase tattoo shop on State Street. This accident has turned me into a billionaire!" We all wish Monroe the best in his new adventure.

Biotechnology has benefited many Turf Engineers, but there are also drawbacks and failures. "The University of Minnesota's Rounder-ready *Poa annua* was a mistake." So says Josh LePine, CEO of Stoughton Transgenics. "Bioengineered crops can't be recalled. I wish the State of Wisconsin had tighter release regulations when the Rounder-ready *Poa annua* was first released. Now those areas that bought and used that first transformed seed are having problems with the transgenic turf escaping into the wild. These aren't the first examples of unforeseen consequences of alien species being introduced,

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deliberately or accidentally, into new environments, as has happened with zebra mussels, Dutch elm disease, kudzu, multi-flora rose and chestnut blight. The delicate ecological balance can be severely affected by a new species."

LePine hopes the new regulations in place will prevent this from happening again. "To release our nitrogen-fixating bentgrass line, 'Nitrogen-free,' Stoughton Transgenics had to conduct thousands of experiments just on the safety issue of escape."

The biomolecular revolution has also affected the Turf Engineer by helping reduce the amount of physical labor needed on the course. Noltner Robotics of Middleton has created a niche for itself in the turfgrass industry by spinning off advancements made with the 'Gene Gunner.' Dave Noltner, who was instrumental in the creation of the first Gene Gunner, used his royalties to invent the first robotics laser mower. Noltner says, "The UW-Madison's alliance with the Wisconsin turfgrass industry has allowed us to bring practical solutions to everyday problems. Our automated laser mowers are now being equipped with weed, insect and disease monitoring devices that were first developed in the laboratories at the UW-Madison."

Jeff Gregos, the Turf Health Clinic (THC) Coordinator, says, "Robotic greensmowers equipped with weed, insect and disease sensors have accelerated progress in pest management. The number of samples coming into the clinic have been drastically reduced, due in part to the turf industry's dedication to research and education. Now the THC spends most of its time helping Turf Engineers adapt to the new technology of gene therapy. Before the turn of the century, the THC's research

effort was focused on chemical control. Now genes and gene vectors make up 75% of our management trials. Biological agents and chemicals are still needed in today's pest management arsenal, but the genes are the THC's big money maker."

The biomolecular revolution has touched many aspects of our world today. James Watson, Nobel laureate who discovered DNA, once said, "We used to think that our future was in the stars. Now we know it is in our genes."

The techniques of molecular

biology have allowed us to read the genetic code of life just as we would read a book. The complete human genome, which was decoded just five years ago (2005), has given us an "owner's manual" for the human being. This has set the stage for science and medicine in this young century. By incorporating these techniques into the realm of turfgrass science, it has given us the almost God-like ability to manipulate turf almost at will instead of passively watching the dance of life. ♣

