Quest #108: Biotechnology

(Christine Young, Program Host) Coming up on Quest: Irradiation, dairy cow hormones and other biotechnology in our foods have not been popular in Maine. Yet, some of us may be eating genetically altered food and not know it. Maine has several world-class research labs using animals like mice and a cousin of the shark to find cures to improve human health, and we have designer drugs from seaweed. What biotechnology has to offer the farms and fishing harbors of Maine. That's what this Quest is all about.

(Narrator) Maine public television's production of Quest "Investigating the World We Call Maine" is funded through a television demonstration grant from Rural Economic and Community Development, part of the USDA.

(Christine Young, Program Host) Hi, I'm Christine Young. Biotechnology may be a hard-to-define science but we know it when we see it. Lab coats and test tubes are a must, as are high powered optics. It's been only 20 years since the birth of biotechnology in California, but in 20 years the frontiers of science have expanded and new industries were launched because of biotechnology. Scientists can now splice different genes together and can essentially act as engineers with our genes. While many of these advances have mind-boggling potential, the science itself is changing so much that many Mainers have a cautious attitude about it all. Kate Arno explains.

(Kate Arno, Segment Host) A few years ago, this would have looked like science fiction for Maine. But not any more. About 5000 Mainers now make their living working in a biotechnology lab like this one.

Biotechnology is a term that is hard to get a handle on. There is a simple definition. Biotechnology is new products developed through biological processes or living organisms. But, that does little justice to today's much broader implications of biotechnology.

(Jennifer Feldman, Monsanto-Nature Mark) We see it as a way to improve the way that we solve problems. It's a way to improve the tools in medicine, improve our production abilities in agriculture, and simply a way to improve the way we do things with a lower impact than some of the ways that we're doing it now.

(Kate Arno, Segment Host) Monsanto is a highly diversified chemical company that makes Ortho lawn products, as well as NutraSweet. What goes on here and in many other biotech labs now is not just traditional plant or animal breeding where strains are crossed and hybrids created. At least not since recombinant DNA or techniques to recombine DNA were mastered, allowing scientists to snip, insert and rearrange genetic material from one species to another. And companies like Monsanto hope these new products will make it easier for farmers like dairyman John Nutting of Leeds to make a living.

(John Nutting, Holstein Breeder) Some biotechnology I'm using myself. You'll see some of my cows are red and white. They're still Holsteins; that's a rare offshoot of the breed. My grandfather used to hide a red and white Holstein. Nowadays, they're worth more than a black one. The question is, if I have a black cow, is she a red carrier? Does she carry the recessive genes for red color? Now, because of a new biotechnology product, I can draw some blood from a cow, send it to a lab; they can look right at the color gene in that blood, in that cow's DNA, and can tell me whether or not that cow is a red carrier. And that's a huge help to me.

(Kate Arno, Segment Host) The biotechnology industry that emerged from genetic engineering raised expectations for plentiful, cheap and environmentally sound biotech products. Tufts' university professor, Sheldon Krimsky, has closely followed the biotechnology industry. Even after 20 years, Krimsky says it has been profits, not social needs, that has driven the development of biotech products. Some critics of biotechnology are convinced that

genetically altered products could harm human health or impact the ecological balance. Krimsky contends many of the fears are unfounded so far because they haven't been proven.

(Sheldon Krimsky, Tufts University) We don't have any evidence now that any genetically engineered food product, for example, has created a human health problem. There's only been a few in the market.

(Kate Arno, Segment Host) There are plenty of scientists who think genetic engineering actually is a much more precise form of breeding than the traditional methods we are now accustomed to. Genetic manipulation is altering just one gene at a time. Selective animal or plant breeding alters hundreds of genes. Peter Mosher of the State Department of Agriculture says we have been altering genes for 4000 years.

(Peter Mosher, State Department of Agriculture) Basically ever since man has settled down and become farmers and planted seed he has also intervened and tried to improve stocks and improve livestock.

(Kate Arno, Segment Host) It is not clear whether Maine will become a hotbed for biotechnology businesses. In the meantime though, it does appear to be a hotbed of sorts for outspoken consumers.

More than most states, Maine has a reputation for consumer wariness when it comes to biotechnology. Most people would agree that not all biotechnology is created equal and that there is probably a difference between what a giant chemical company wants to sell us and what some of the research labs in Maine, such as Jackson Laboratory, do with genes for the sake of medicine.

(John Nutting, Holstein Breeder) If you asked yourself what's the fastest growing line of soft drinks being sold, it is Snapple. It is all natural. What's the fastest growing cough drop on the market in sales? Ricola, all natural. People want more and more natural foods. As one lady said at a public hearing a few years ago on our bovine growth hormone bill in Augusta, she says, I'm much more comfortable talking on high tech than putting high tech in my mouth.

(Kate Arno, Segment Host) When biotechnology makes the news in Maine, it often has a consumer angle to it. First came the debate over the irradiation of food. When food is exposed to irradiation, it stays fresher longer, so some food processors wanted to irradiate produce sold in Maine.

This former legislator remembers the debates that began in the late eighties.

(John Nutting, Holstein Breeder) We on the AG committee talked it over and had a public hearing and there wasn't a single consumer that came before the committee that wanted anything to do with irradiated food. Also, some people at the University pointed out that there is no food irradiation done in Maine, so really the sale of irradiated food in Maine guaranteed one thing, and that was that that food came from away.

(Kate Arno, Segment Host) The next biotech controversy in Maine was a new product from Monsanto, to get dairy cows to produce more milk. After 15 years of biotech research this is Monsanto's first genetically engineered product to hit the market, the brand name is Posilac but it is also known as BST or even more commonly as BGH for bovine growth hormone. Opponents of biotechnology held up federal approval of this hormone for a decade and now several years after it hit the market a huge hurdle remains for Monsanto to recoup the hundreds of millions of dollars it invested in BGH. Monsanto is not going to make much money on BGH in Maine, but it is not just because consumers are leery about the synthetic hormone in their milk. Maine dairy farmers, like many others across the country, are skeptical too.

(John Nutting, Holstein Breeder) The cow of the '90's is under much more self-induced genetic stress than she was in the '50's. This product is just kind of putting cows over the edge.

(Kate Arno, Segment Host) Most Maine dairy farmers have signed affidavits with their milk distributors promising not to inject their cows with BGH. One dairy, Oakhurst, hopes to appeal to customers by assuring them that their milk does not come from hormone injected cows.

(Stan Bennett, President, Oakhurst Dairy) Milk is and should be perceived to be nature's most nearly perfect food and the last thing a food industry needs is a concern, whether real or imagined, about the healthful nature of the product.

(Oakhurst Advertisement) We buy all our milk from nearby family farms which have earned the government's top rating of any major milk supply in New England. We see no need to give our cows any artificial growth hormones. We see no need to change what we do at the diary either. After all, the fresh, natural taste of Oakhurst's milk has made it Maine's favorite brand for 75 years.

It may be that 10 years down the road we'll find that these substances are totally innocuous, but that is not my concern. My concern is fulfilling the needs of our dairy consumers here in the state of Maine, and they have told us they don't want it, they have concerns about them. Whether they are realistic or real or perceived, that doesn't matter. We are in the business of marketing milk, not marketing somebody's drugs.

(Kate Arno, Segment Host) It is estimated only five percent of U.S. Dairy Farmers are using BGH. Some of them may be in Maine, and are sending their milk to out-of-state dairies. Many dairy producers are concerned about the side effects to the synthetic hormone. The Federal Drug Administration required Monsanto to include a warning label listing 21 possible health problems for cows.

(John Nutting, Holstein Breeder) The warning label is 32 pages long. It talks about an increase in body temperature, and diarrhea, and bloating, and mastitis and foot problems and, you know, just every disease known to cows.

(Kate Arno, Segment Host) Some critics of biotechnology think there may be some human side effects that we do not know about.

(Sheldon Krimsky, Tufts University) We have not done human experiments on this, on BGH. That is, we have not had a large control group and an experimental group and fed them BGH milk. That has not been done.

(Kate Arno, Segment Host) The first state legislation to prevent BGH from being used on dairy cows was passed here in Maine. Our state legislature approved two temporary bans. Then a permanent voluntary labeling law. Sharon Tisher teaches environmental law at the University of Maine.

(Sharon Tisher, University of Maine Resource Economist) I think it is clearly preferable to have a federal law but, in some areas of genetic engineering and labeling of foods, if the federal government does not act soon enough and effectively enough to require labeling, I think that Maine really has to seriously consider moving ahead with its own labeling requirement.

(Kate Arno, Segment Host) There is a genetically engineered product that has been sold openly in Maine grocery stores. Even though it is not required to be labeled in Maine, pick up a MacGregor tomato at the store, and you can see a sticker saying it is grown from genetically modified seed, and nearby you will see some brochures explaining the genetic process used in making this tomato so that it can ripen slower and not become mushy on store shelves.

(Sharon Tisher, University of Maine Resource Economist) I am very impressed by what Hall Gene, which is the manufacturer of the MacGregor tomato, has done as far as labeling. It does not go quite as far as the bill that was

proposed in the Maine Legislature would have required. That bill would have required that the source of the genetic material that is added, i.e., a bacteria in the case of the MacGregor tomato-be identified specifically and that the reasons for that introduction be stated.

(Kate Arno, Segment Host) Monsanto recently bought shares of the company that developed the MacGregor tomato.

One of the unique features of this new tomato is that in every single one of its cells a new antibiotic resistant gene has been introduced. Some scientists wonder whether we really want to consume food that is resistant to common antibiotics. What if we needed that same antibiotic to fight the flu or some infection.

(Sheldon Krimsky, Tufts University) Yes definitely, if it is going to be marketed, it absolutely should be labeled, and those people who want to be part of the human experiment, to see what the next five or ten years are like, they may do so. And others who say, I am not ready for that yet, I want to see what the first million people are like when they take this.

(Kate Arno, Segment Host) The MacGregor tomato is the first whole food born of biotechnology and many more are on the way. Antibiotic resistant genes are being introduced in all kinds of produce. Squash, melons and berries to name a few. In the research stage are health conscious foods like potatoes for French fries and potato chips that absorb less fat and coffee beans that are naturally caffeine free.

And in the field trial stage now in Maine is the so-called pesticide in a potato, New Leaf. Monsanto scientists splice into seed potatoes a toxic gene from soil bacteria, the microscopic organisms found in the earth. With this gene, potatoes can produce their own insect-killing chemical to ward off the Colorado potato beetle, a major pest of potatoes. The gene becomes part of the potato which, in turn, synthesizes the toxin continuously throughout the growing season. This toxin is now used in spray form by many organic and sustainable agriculture farmers to control the beetle. But because the toxin will be in the genetic code of this new kind of potato, there is a chance the bugs will build up resistance to it in a few growing seasons which means it would no longer work as an organic pesticide.

(Jennifer Feldman, New Leaf Representative) It is important to Nature Mark as well as to consumers, to potato growers, and that is why we have taken a proactive role in establishing tactics to prevent resistance developing in the Colorado potato beetle, and this is the first time that a resistance management plan has been developed for a pest control agent before it has reached the market.

(Kate Arno, Segment Host) Once the New Leaf potato makes it to the market, consumers won't be able to tell by tasting it whether it is the one genetically altered with a pesticide. They may not know by looking at it either, because right now there are no plans for the federal or state government to require labeling it as genetically altered. Maine has had a couple of state commissions reviewing biotechnology issues. The current one is considering recommending that the federal government mandate labels on all genetically engineered products. Sharon Tisher is the public interest representative on that panel.

(Sharon Tisher, University of Maine Resource Economist) As many as 85% of consumers say they want products labeled, so they know whether a product is genetically engineered or not, and there are a variety of different reasons. There may be economic reasons; there may be personal, philosophic reasons, reasons related to vegetarian diets or religious preferences that consumers may want to know whether something has been genetically engineered or not. Even the FDA agrees there is no way in the laboratory to test to accurately predict what the reaction from a mass consumption of these products is going to be, when you are talking about protein material that has not existed in the food chain before.

(Kate Arno, Segment Host) The biotechnology commission also is looking at recommending to the state legislature a Science and Technology Academy of Experts. This group of scientists would acquire scientific information for legislators and help them make decisions on new technologies like the New Leaf potato or even reformulated gasoline.

(Sharon Tisher, University of Maine Resource Economist) Our charge is to focus on what the state of Maine is doing now and what the federal government is doing now to regulate biotechnology and genetic engineering and to decide what really the appropriate role for the state of Maine is in that regard.

(Kate Arno, Segment Host) Besides the questions of how much consumers should now about this emerging area of science, there are even broader ethical issues at stake with biotechnology, such as how far this industry should push the boundaries of science in altering the genetic codes of organisms to find new products and new cures.

(Kenneth Paigen, Jackson Laboratory Director) Any new technology is going to have its problems as well as its blessings. When I think about changing genes and manipulating genes, yes, I worry about how the world may use it down the road. Then I look at a cancer patient and I say If I can cure that patient with what I am doing or I can cure the next patient with what I am doing, do I stop? Do I deny the benefits now for people who are ill or sick because I am worried about what will come in the future? I have to say I will use the benefits now and hope that we deal with it sanely in the future.

Music

(Christine Young, Program Host) There is another ethical debate over biotechnology that reflects on the work of hundreds of scientists at Maine's nonprofit research laboratories. It is the more pointed ethical issue of animal rights. The use of animals in research is upsetting to some people, like members of PETA, People for the Ethical Treatment of Animals.

But for these research laboratories which have gained world wide recognition for their work the animals are invaluable.

Barbara Noyes Pulling has more.

(Barbara Noyes Pulling, Segment Host) These Maine scientists, or investigators as they would like to be called are making discoveries to help cure cancer, heart disease, birth defects and cataracts. They do that by learning about genes and to learn how genes work in us humans, scientists study how they work in mice. For nearly 70 years now the scientists at the Jackson Laboratory in Bar Harbor have been making pioneering discoveries in genetics. These and other findings are helping us better understand and eventually treat and cure major human health problems. Yet, much of this progress in genetics would not be possible without one of science's most important research tools, the laboratory mouse. Why are these small mammals important to Jackson Laboratory and other scientists? Well, like it or not, mice are much more like us humans than we care to admit. Like us, mice get human diseases, they get heart disease and cancer, obesity and osteoporosis. Mice age, their eyesight and hearing go, and their joints develop arthritis. Mice and people have many of the same genes or molecules in our cells that determine what we look like and how healthy we are. These genes do the same things in our bodies as they do in mice. If we put a gene from a human cell into a mouse, it works pretty much as it would in us.

(Kenneth Paigen, Jackson Laboratory Director) The mouse has become the paramount experimental organism to understand human biology. It is our experimental surrogate. It is the place we can do the experiments that we would not think of or want to do in ourselves, and yet the answers are important for us. They are meaningful.

Squeak! Squeak!

(Christine Young, Program Host) Mice also are convenient for research. They are small, easy to handle and inexpensive to feed and house. It costs just a few cents a day to care and feed for mice at Jackson Laboratory. Rats are 10 times more expensive. Mice breed prolifically and they live the equivalent of a human lifetime in just a few years helping the search for new ways to treat human disease. Revolutionary new technologies, developed in part at the Jackson Lab, allow scientists to engineer genetic material in mice creating more possibilities for research. Using microscopically fine needles, scientists can either insert entirely new genes into mice or replace and knock out existing ones.

(Kenneth Paigen, Jackson Laboratory Director) It's not the gadgets. It's not the machines. It's the ways of doing things that have been invented, and the outcome of all that is the tremendous explosion in the amount of information, how much we know, how much we can write down some place on a piece of paper that we know. We estimate right now that the doubling time for information in mammalian genetics is actually less than three years. We know four times as much as we did six years ago.

(Barbara Noyes Pulling, Segment Host) The nonprofit Jackson Laboratory is now the world's largest genetic research laboratory for mammals, and it is home to some of the world's brightest minds in genetics. It also attracts major funding, largely because of the success rate of its research which is twice the national average.

Cancer research has been the Jackson Lab's primary focus ever since it was founded in 1929. Research teams at Jackson Laboratory study many different forms of cancer. In recent years it has branched out to catalog genes and develop mouse models of heart disease, cystic fibrosis, spinal cord injuries, and Down's syndrome.

Maine native Muriel Davisson heads the genetic modeling research project.

(Muriel Davisson, Jackson Laboratory/Genetics Research) An animal model of any kind, and we work with mice here obviously, is something that mimics a human condition, so if you have cystic fibrosis in human beings, you can make a mouse or actually a lot of them occur naturally that has the same clinical symptoms as the human disease, that is cystic fibrosis. Then, you can use that mouse model to determine what goes wrong in human patients.

(Barbara Noyes Pulling, Segment Host) The Jackson Laboratory is also renown for having the world's largest variety of high quality mice to supply researchers world wide. More than two million mice are shipped each year to 12,000 labs including virtually every medical school and training university in the United States. In many cases, the laboratory is the world's sole source for important mice stocks and strains. Recently, the Jackson Laboratory has become an international repository for more than 200 genetically engineered mice.

(Kenneth Paigen, Jackson Laboratory Director) Well this began way back in the early 30's when we began providing mice to other researchers. It has just grown over the years. There are hundreds and hundreds of special strains and mutants that people use for research purposes and nowadays the ones that we engineer.

(Barbara Noyes Pulling, Segment Host) Another important aspect of the Jackson Laboratory's work is freezing mouse embryos and sperm. It is home to the world's largest frozen mouse embryo repository which preserves important stocks and strains of mice for use in future research. Using what is called cryopreservation, scientists at Jackson Laboratory can preserve valuable embryos. If needed they can thaw frozen embryos and sperm years later and implant them in surrogate mother mice to revive a genetically important strain. These are actual unfrozen mouse sperm.

(Kenneth Paigen, Jackson Laboratory Director) It is often very hard to predict over time what will be important 10 to 20 years from now. It is very expensive to keep the mice alive on the shelf all that time, uncertain about

what may come, so we have developed a method to preserve them as frozen embryos. It is really the same technology, the same methods, that were originally developed here for in vitro fertilization.

(Barbara Noyes Pulling, Segment Host) The Jackson Laboratory is also part of a huge world-wide project to decode the entire human genetic code or genome. Researchers are in the process of cataloging three billion bits of biological code for the international human genome project.

(Kenneth Paigen, Jackson Laboratory Director) If you are going to do an experiment, it is tremendously important to know what has been done before. There is a vast amount of information out there. You need to access the little part which is relevant to your experiment. There is no way to do that except to use the computer data bases.

(Barbara Noyes Pulling, Segment Host) The Jackson Lab is one of a growing number of biotechnology corporations which make up one of Maine's fasting growing economic sectors. There are more than 40 private companies, several academic institutions and several internationally known nonprofit research labs in the state like the Jackson Laboratory. But, we rank near or at the bottom of several critical categories for attracting additional biotech businesses.

(Barbara Noyes Pulling, Segment Host) We have a dismal track record for spending money on research and development, for getting federal grants for academic research and for attracting science and engineering students. Biotechnology still has a low profile in Maine even though some impressive work is being done here. Terry Shehata of the Maine Science and Technology Foundation works to spur more development of biotechnology in Maine.

(Terry Shehata, Maine Science and Technology Foundation) Our mission in life is that based on the overall economic and education vision of the state, our role is to chart the pathway that science and technology can be used to enable that, and invest in organizations or individuals that will take us in that direction. One of the areas that we have been focusing on for the past few years is in biotechnology because of the high degree of potential that that industry has in the state of Maine.

(Barbara Noyes Pulling, Segment Host) Some of the largest biotech employers in Maine are the nonprofit research labs.

In addition to the Jackson Laboratory, downeast Maine is home to another well-respected research facility that uses animals to study human health. The Mount Desert Island Biological Laboratory turns to the sea for its clues. The MDI Bio Laboratory near Bar Harbor doesn't get the publicity Jackson Laboratory does even though it has been around for a century.

Most of the scientists that work here come in the summer when they are not teaching. It is an informal setting where families are welcome, yet it is one of the premiere scientific research institutions in the world, and one of the few that concentrates on studying the workings of cell membranes. Cells act much like our skin does. They breath and sweat through channels, taking in nourishment and pushing out waste. The skin of cells is called membranes, and their protective yet permeable nature enable our cells to maintain the delicate internal balance that makes life possible.

(James Boyer, MDIBL Membrane Toxicity Studies) Of course, that's our ultimate goal, to actually clone the gene that codes the information for the channel so we can reconstruct the channel, amino acid by amino acid, each building block, so we will have actually in the end a three-dimensional picture of exactly what that channel is like.

(Barbara Noyes Pulling, Segment Host) The MDI Bio Lab made a name for itself through its work on kidneys.

Regulating the balance of salt in the kidney is critical to maintaining normal blood pressure. The dogfish shark found in the waters off the coast of Maine has proven to be a good model for how many cells work.

Fish are cold blooded. Their temperature is much lower than ours, and that slows down their physiological processes which make it easier to study what happens at the cellular level.

(Barbara Kent, MDIBL Administrative Director) Their metabolism is slower and everything happens at a slower pace, so if we are trying to see what how a mechanism works, it is kind of like doing a slow motion film and really being able to see what happens.

(Barbara Noyes Pulling, Segment Host) Other cell membrane studies going on at the MDI Bio Laboratory examine how environmental toxins affect cells.

(James Boyer, MDIBL Membrane Toxicity Studies) What we are learning now is that certain of the substances, particularly substances like mercury, are quite damaging at very low concentrations, the kind of concentrations that one might see in the environment.

(Barbara Noyes Pulling, Segment Host) The MDI Bio Laboratory is also into plastics, sort of. Scientists want to figure out how to use the proteins in skate's egg shells to repair human bones. The skate is a cousin to the string ray and shark. There are at least five species of skates around Mt. Desert Island, some of which are four feet wide. Unlike most fish, skates only lay one egg at a time. Egg cases with the strength and resiliency of plastic protect skate eggs for a year or more in the harsh waters of the North Atlantic before the juveniles hatch. It is believed that egg shells like this have survived the rough waters of Frenchman Bay for five years or more without breaking down. Old ones, black and covered with barnacles, are a familiar sight on Maine beaches and are known as mermaid's purses.

(Tom Koob, MDIBL Senior Investigator) It had been thought for a long time that the major protein in the skate egg capsule is collagen, and it was interesting that this material was produced in an egg which would then be stabilized by some sort of cross linking mechanism which made it very stable in the marine environment.

(Barbara Noyes Pulling, Segment Host) Work at the MDI Biolab with skate cases may lead Koob to a new material to fill spaces in children's bones after corrective surgery.

Another standout among Maine research laboratories is in West Boothbay Harbor. For the past 20 years the Bigelow Laboratory for Ocean Sciences has been studying the biological workings of oceans. Some Bigelow scientists have made the environmental issues of New England waters a priority. Most of the research going on here at Bigelow centers on marine phytoplankton and zooplankton, microscopic plants and animals that are on the lowest rung of the ocean's food web yet which are the basis of all life in the sea.

(Mike Siarachi, Bigelow Laboratory Biological Oceanographer) These microorganisms form the fabric of life in the ocean. Everything else is just, you know, sort of embroidery on that fabric where things like fish and the whales, they could all go away, and the plankton community would still exist and function exactly like it is.

(Barbara Noyes Pulling, Segment Host) Bigelow Laboratory houses an impressive marine zoo, but it is a zoo of plants not animals, although it is hard to tell when the organisms are this small. In this small clapboard building there are aisles of refrigerators filled with rack upon rack of test tubes of microscopic plants. These are phytoplankton, phyto from the Greek word for plant and plankton for drifting, which is what these plants do on currents and tides. The largest of these plants is just a few thousands of an inch wide. The Provasoli Guillard National Center for Marine Phytoplankton at Bigelow is a collection of over 1000 phytoplankton samples for scientific and commercial use.

(Mike Siarachi, Bigelow Laboratory Biological Oceanographer) The culture collection is a rich source of biological material, the likes of which exist nowhere else in the world. It would be like if there were some kind of new rain forest in terms of the numbers of species there that no one had ever gone in and looked at what is there.

(Barbara Noyes Pulling, Segment Host) Like plants on land, phytoplankton bloom in the spring. When spring sunlight creates a surface layer of warm water, plankton come alive. In that layer everything comes together for them. They have sunlight for photosynthesis and nutrients brought up from the deep by winter turbulents. There is an orgy of cell division, sometimes as much as 7 times a day. These satellite images show this bloom of plankton in the Gulf of Maine.

To see the plankton individually, scientists at Bigelow use what is called a flow cytometer. A sample of seawater is compressed into a thin stream, and the one-celled plants are marched in single file, 2000 per second, past an interrogation point. There they are bathed in laser light which gives them a fluorescent glow. The color of that glow indicates what pigment a cell contains. The way it scatters light reveals its size and shape.

(Terri Cucchi, Bigelow Lab Senior Technician) So I put the sample in here, and you see this little thin tube. Well, that is actually under nitrogen pressure, nitrogen gas. It's actually being forced up this tube and then injected inside that stream of fluid that then carries the cells through the laser beam.

(Bigelow demonstrator) This is a sunlight area right over here, you see ...

(Barbara Noyes Pulling, Segment Host) Bigelow's expertise in satellite imagery has benefited many public schools across Maine. The Guya Crossroads Project involves some 4000 students and helps then view their school yards, backyards and communities using satellite photos and hand-held receivers. Bigelow also is now affiliated with the University of New England in Biddeford and its Marine Studies Program.

(Maureen Keller, Bigelow Lab Research Scientist) At Bigelow, we don't have students and students bring life into a laboratory because they are so enthusiastic and curious about things, so from our viewpoint what we really wanted was an interaction with students. We are all getting on. We have all been here a while. We feel like we have things we would like to pass on and so we what really wanted was that interaction with students.

(Barbara Noyes Pulling, Segment Host) Many of the findings coming out of Maine's nonprofit laboratories are exported to help scientists and universities and hospitals around the globe.

These research institutions along the Maine coast have built solid reputations for scientific research that can be used elsewhere to find cures and new techniques. Yet there are some instances where nonprofit research labs are forming alliances with biotechnology entrepreneurs in Maine.

One of the most successful for-profit biotechnological firms in the state is IDEXX. Founder David Shaw has a special relationship with the Jackson Lab. In a nutshell, Shaw converts medical technology for humans into products for the pet health market.

(David Shaw, IDEXX founder/CEO) By becoming an affiliate and paying a membership fee there, we have access to their scientists in a broad range of areas.

(Barbara Noyes Pulling, Segment Host) When you look at what is going on in biotechnology in Maine, you can see where some research laboratories and entrepreneurs have come full circle. It is almost like karma. The labs often use animals to figure out how to improve human health, and some of those same scientific findings for us humans are now being used to take better care of our pets and other animals.

Music

(Christine Young, Program Host) The for-profit companies providing biotechnology profits and services have been described as a diamond in the rough for Maine. We may not yet be a hotbed for biotechnology, but we are working on it. One way of doing that is by attracting a certain breed of company, a company that caters to Maine's ready-made markets by using our natural resources. As Dana Hutchins tells us, small and large biotechnology companies are coming up with some remarkable ideas.

(Dana Hutchins, Segment Host) Like many of the 40 biotechnology companies doing business in Maine, David Shaw's IDEXX company exports its products out of state and in many cases globally. IDEXX has over 100 products that are sold in 50 countries. IDEXX is so successful because it not only makes test kits but the slides and test tubes to go along with them.

(IDEXX representative) This is IDEXX's original heartworm test. It had about six or eight agents and eight steps and took 15 to 20 minutes. This is IDEXX's newest heartworm test. It is a one-step test and takes about five minutes.

(Dana Hutchins, Segment Host) It's a marketing success story that has been compared to the one Gillette has enjoyed with its razors and razor blades. IDEXX also manufactures equipment such as computers and instruments for tests to go along with its diagnostic products.

(David Shaw, IDEXX Founder/CEO) The strategy was identify under-served niches, identify world class technologies that we could apply here and to commercialize those technologies worldwide.

(Dana Hutchins, Segment Host) Another Maine giant in biotechnology is FMC in Rockland. Here at FMC's bioproducts division, seaweed is transformed into a gel and powder for more than 40 bio-research products. Extracted from the red seaweed which comes from around the world, is a chemical called Agar. For the past 25 years FMC has been making the gel and powder Agarose for use in genetics research, diagnostics, and DNA analysis in laboratories worldwide.

(Noriko Kusukawa, FMC Products Technical Director) The Agarose as you can see is pretty much like jelly. What we do with this is we put the DNA sample on one end and we place this tray in an electrical field. The electrical field then moves the DNA towards the positive electrode, and that is how you get the DNA band pattern. Now, it is very important that the Agarose is very pure and does not interfere with this very important process.

(Dana Hutchins, Segment Host) No longer in seaweed form, the agar comes semi-refined. It is washed, crushed, dried, and processed into Agarose. The gel is especially useful in DNA laboratory work. Its complex sugars don't interfere with the electric currents that are run through the gel to separate DNA strands into their band patterns.

(Noriko Kusukawa, FMC Products Technical Director) We are looking at the results of the DNA analysis. The gels are stained in different stains here. The orange one is more commonly used in labs, and the green one has a slightly higher sensitivity so you can pick up smaller amounts of DNA gel.

(Dana Hutchins, Segment Host) Most other Maine biotechnology companies are entrepreneurial and cater to niche markets like FMC and IDEXX but on a much smaller scale. Eight out of ten biotech businesses have fewer than 20 employees. Donald Colbert heads the Center for Innovation & Biotechnology.

(Don Colbert, Center for Innovation & Biotechnology Director) I think part of the thing you are looking at is to

set up an environment, which we are trying to do at the Center, that is really one focused on home grown. We are trying to facilitate what we have and there is this initial nugget that is trying to grow into a critical mass, and we are approaching that.

(Dana Hutchins, Segment Host) The down side of biotechnology now is that it is very portable. It can be done anywhere, and also be taken anywhere. But many in Maine think we will be most successful at attracting and keeping biotechnology companies if we build on our assets. That's why they are encouraging companies to look at biotech products that help fishing, agriculture, even the environment.

(Don Colbert, Center for Innovation and Biotechnology Director) We haven't nearly, as a nation, put as much emphasis into that area and in a lot of ways we're playing catch up with both the Japanese, the Russians, Europeans.

(Dana Hutchins, Segment Host) Aquaculture is getting a lot of attention. Today's Maine fish farms grow top quality Atlantic salmon, steel head trout, American oysters, and Nori, the seaweed that is used to wrap sushi. It is hoped tomorrow's farms will produce cod, haddock and flounder, fish species from New England waters that have been favorite since colonial times.

Maine fish farms also may become sources of biotech compounds to help fight human disease. Michael Hastings directs the Aquaculture Innovation Center in Orono.

(Michael Hastings, Marine Aquaculture Innovation Center Director) It's a two-way street. There are things that biotechnology can develop for aquaculture, and there are things that aquaculture can supply for the biotechnology industry, and so we are looking right now at both of those possibilities.

(Dana Hutchins, Segment Host) There are several fish farms in Maine that Hastings describes as doing aquaculture for biotechnology. Coastal Plantation in Eastport not only grows seaweed for wrapping sushi, it does a larger business growing and selling the chemicals in the seaweed for diagnostic dyes. Coastal Plantation's Nori, a red seaweed, has already proven valuable in the biomedical industry.

(Ike Levine, Coastal Plantations President) We're working on cancer drugs. We are working on AIDS antibodies. We are looking at developing the next generation of artificial sweeteners. So, the range of possibilities are just tremendous.

(Dana Hutchins, Segment Host) But Levine has more plans for his seaweed. Using transgenics, a technique for inserting new genetic material into an animal, or in this case plant, Coastal Plantation is getting into the designer drug business with its seaweed.

(Ike Levine, Coastal Plantations President) What we are looking to do is take very expensive drugs that are very hard to make, implanting that genetic material into Nori. Nori is an extremely fast growing plant, and we can utilize the entire plant. We take that concept. We take that genetics, we put it into Nori, we grow up the Nori, and then we extract the drug of choice out of the Nori.

(Dana Hutchins, Segment Host) In another year, Levine hopes to begin testing the transgenics in seaweed growing drugs for cancer, AIDS and bacterial infections. This new process should prove less costly and more effective than traditional methods that use bacteria.

(Ike Levine, Coastal Plantations President) In terms of our research, we are looking to be able to minimize that cost of expensive drugs. We are looking to take the drugs that are $100 a prescription, $500, $1000 a treatment and bringing it down 30-70% less in terms of the cost of manufacturing.

(Dana Hutchins, Segment Host) There are several biotechnology firms in Maine that specialize in the needs of agriculture.

Amidst these sterile hoods and thousands of test tubes are the makings of brand new strains of potatoes, but these are spuds most Maine potato farmers would die for. PTS Laboratories in Hamden is in the business of creating virus and bacteria-free potatoes.

(Dave Rawcliffe, PTS Laboratories Director) The seed is the basis for everything, and if you start with very clean, clonally stable seed, then you are that much better off. The commercial production is tough enough as it is, and to start with poor quality seed you are in the hole already so to speak.

(Dana Hutchins, Segment Host) This kind of biotechnology is not done by altering the genes but through the more natural approach of removing pathogens. PTS has 26 strains of potatoes bred in vitro to be free of six major viruses such as leaf roll and two troublesome bacteria, ring rot and soft rot.

(Dave Rawcliffe, PTS Laboratories Director) The wariness of it being a new technology has been pretty much taken care of, because it has been around so long. The only barrier now really is cost, and we feel we have addressed that and brought the cost down that it should be a commercially viable venture.

(Dana Hutchins, Segment Host) Biotechnology in Maine also comes in the form of a company that specializes in helping farmers and others rid themselves of their worst waste problems.

Woods End Research Laboratory in Mount Vernon can do that and as a bonus it also has helped farmers understand their soils better. For several years now, Woods End has preached the importance of composting and how it can handle the most troublesome waste problems. Founder Will Brinton's motto is "Compost happens."

(Will Brinton, Woods End Research Laboratory President) There was a whole birdhouse full of birds, I think it was at least 75,000 and they were asphyxiated during the fire and so it presented this immediate disposal problem of all these carcasses. They either had to be hauled off to the landfill at tremendous haulage cost or disposed of by incineration which is an extremely expensive on-site, and I simply suggested let's compost them, and at first people said "No,", and I said it is simple, you know, you mix it with manure soil and sawdust, and so the DeCoster Company hired us to set up these test piles, and we made soil out of those birds in three weeks, and you could not tell what they had been.

(Dana Hutchins, Segment Host) Brinton has turned the humble art of composting into a high tech biotech affair, but he started with a very basic premise. Success in composting, as in agriculture as a whole, depends on microbiological activity and microbiology is still poorly understood.

(Dave Rawcliffe, PTS Labratorie Director) One of the reasons it's not easy is that there is such a mixture of events taking place at very high speed in composting including these bacteria that are multiplying at high heat. Every 20 minutes you have another generation. That's really amazing because in the soil it might be every five days or every several months in some cases.

(Dana Hutchins, Segment Host) Composting has been around since ancient times. It is a natural biological way of decomposing materials which is characterized by elevated temperatures in the range of 120o to 160 o. Composting happens because of microbial activity. Microbes turn waste material into plant nutrients and a soil-like material humus. The heat given off is a byproduct of their work. Woods End has figured out how to compost fish scraps, potato culls, paper sludge, brewery waste, even petroleum-based products like gasoline and motor oil. It seems no job is too big for Woods End. Scientists there will come up with the right recipe for all kinds of

waste.

(Dave Rawcliffe, PTS Laboratories Director) With this, you can get out on the floor, take a test, get a result quickly and reliably, and it does not require a technician or any chemistry or anything. So, this example here that I have set up. This is fresh compost that lights the thing up bright yellow. It tells you it is just starting the process. This compost is about half way finished, and here is a completed compost that would be ready for marketing or use in ? Mix for gardeners.

(Dana Hutchins, Segment Host) Being as environmentally conscious as it is, Maine is a prime place for a new facet of biotechnology, environmental diagnostics.

ImmunoSystems in Scarborough has developed some unique technology to detect pesticides and chemicals in food, water, and soil. The company started in 1981 with products for human diagnostics then moved into animal diagnostics and now environmental detection.

(Bruce Ferguson, ImmunoSystems Chief Scientific Officer) I wanted to adapt the same technology for environmental diagnostics that was used for human diagnostics.

(Dana Hutchins, Segment Host) ImmunoSystems Enviroguard Test Kits can now test for 49 compounds including herbicides, insecticides, fungicides and industrial contaminants like dioxin and PCD. In as little as 7 to 15 minutes' time, these tests can detect some toxin concentrations in parts per billion and even parts per trillion.

(Bruce Ferguson, ImmunoSystems Cheif Scientific Officer) So the way to get going is to begin by adding four drops of the control, and this is a negative sample, to the first two tubes, and I have created here a sample of atroscine at one part per billion. Now one part per billion is the equivalent of trying to measure approximately one teaspoon of tea in two Olympic-size swimming pools. So, we will remove the equivalent of four drops of our sample into these antibody-coated tubes. We will follow that with another reagent that comes in the kit which is an enzyme, chemistry reagent.

(Dana Hutchins, Segment Host) ImmunoSystems pesticide residue kits are easy to use, portable, and less expensive than other methods. They require little if any sample preparation and no special training to use. Customers include the Federal government and food processors.

(Bruce Ferguson, ImmunoSystems Chief Scientific Officer) In this case the cases are interpreted by looking at the colors in the tubes. These are the control tubes. These are the sample tubes, and the interpretation is that if the sample tubes have less color than the controls, then they are indeed positive for atroscine and in this case it is very dramatic that the sample indeed had atroscine in it.

(Dana Hutchins, Segment Host) ImmunoSystems uses antibody-based technology which before now was used just for clinical diagnostic work. Antibodies are fighters of disease and infection in immune systems. Here, antibodies are used to detect toxins and come from laboratory animals.

(Bruce Ferguson, ImmunoSystems Chief Scientific Officer) In order to produce antibodies to pesticides, we inject rabbits, sometimes goats, sometimes mice with proteins that have these pesticides stuck to them, and we are trying to trick the rabbit, the goat or the mouse and to make an antibody against what he believes is to be a foreign substance.

(Dana Hutchins, Segment Host) This is not a new technology. It has been around since 1960 and since then has been widely used for detecting hormones, drugs, viruses, and pregnancy.

ImmunoSystems is one of those biotech companies that have been bought out. Milipore is its parent company, so even though Maine may not be on the edge of a major breakthrough in biotech companies setting up shop here, we are finding ways of playing to the strengths of our traditional industries: Farming, fishing, and tourism.

(Christine Young, Program Host) Compared to other states, Maine lags far behind in its commitment in attracting new biotechnology industries. The companies and labs already in the state run at subsistent level with not enough revenue for new research to develop new products and not enough to effectively promote or sell what they have already produced.

Some advocates think biotechnology is revolutionizing some industries. It is already growing exponentially and is expected to continue its rapid expansion into the next century. And, despite being slow out of the blocks, Maine is enjoying some of that growth.

Next month on Quest, how to stay healthy in Maine and how to better manage your own health care. Until then, I am Christine Young. Thanks for joining us.

Maine's Public Television production of "Quest: Investigating the World We Call Maine" is funded through a television demonstration grant from Rural Economic and Community Development, part of the USDA.

Music