DATELINE LOS ALAMOS

NEW TOOL DEMONSTRATES A-MAIZE-ING RESULTS

LEAN, MEAN GENE MACHINE WILL HELP CORN GROWERS PRODUCE A BETTER CROP

Corn production involves more than providing a tasty side dish at dinner. Corn and its products also feed farm animals, flavor America's favorite soft drinks, and provide oil for lotions and cooking. The world's largest seed producer, Pioneer Hi-Bred International of Iowa, recently teamed up with Los Alamos to develop a tool that can rapidly identify the genetic sequences in particular strains of corn that may increase their productivity.

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Corn, one of the world's oldest cultivars, is subdivided into more than 260 races. The 7,000-year-old species has an enormous plant genome containing as many as 30 genes that may influence yield alone.

The U.S. corn market produces nearly 9.3 billion bushels a year worth more than $18.7 billion. The yearly value of the corn seed market is nearly $3.1 billion. Seed experts consider corn the single-most-important commercial seed, making it the holy grail of agricultural genetic engineering because it potentially offers the biggest return on the research investment.

The new "gene machine" developed by Los Alamos and Pioneer Hi-Bred researchers uses two lasers and genetic probes bound to dyes that fluoresce when struck by laser light. The genetic probes contain nucleic acids that make up complementary strands of a specific genetic sequence that may be a key in producing more yield or building a better resistance. Part of the corn's DNA molecule is unzipped and mixed in a solution containing the probes. If the DNA strands possess the information that researchers are looking for, the DNA molecule will bind with the complementary probes.

Based on the single-molecule detection technology previously developed at Los Alamos, researcher Alonso Castro drips the probe solution through a tiny capillary tube where individual molecules are struck by the laser light. The dyes attached to the probes fluoresce and emit light that is detected and measured by computers.

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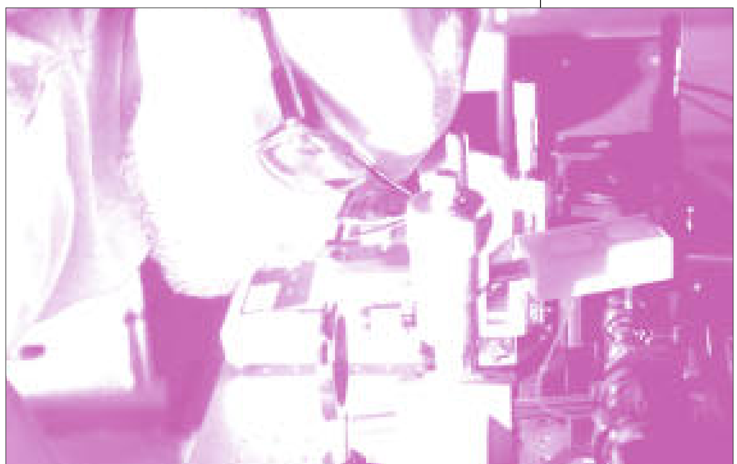
Both attached and unattached probes in the genetic soup fluoresce. To distinguish the free probes from the ones bound with DNA, Castro and Pioneer Hi-Bred scientist John Williams use two dyes chemically tied to opposite ends of the nucleic acid string.



↑ The Los Alamos "gene machine" directly detects small amounts of DNA faster than methods now used by seed researchers and molecular biologists. Here, researcher Alonso Castro demonstrates how the desired genetic sequences of corn are identified by using two lasers and genetic probes bound by dyes that fluoresce when struck by laser light.

The beginning of the strand is linked to a red dye marker and the end is attached to an orange dye. The computer graphs the peaks of light emitted by the fluorescing probes. When a pair of orange and red peaks line up on the graph, Castro knows he has an attached strand because they fluoresce at nearly the same location on the plotted graph.

If the peaks appear randomly, showing no alignment on the computer graphs, the probes are unattached. Attached probes indicate the presence of the desired genetic sequence.

Castro's gene machine can directly detect smaller amounts of DNA faster than methods now used by seed researchers and molecular biologists. Seed producers currently use a slow, labor-intensive method that uses radioactive isotopes measured by X-ray films to identify length-separated DNA strands. In many cases, the DNA sample needs to be amplified beforehand by the polymerase chain reaction, a time-consuming step not necessary with the Los Alamos method.

Castro and Williams have successfully demonstrated the process by detecting specific sequences of DNA in herring sperm purchased from a commercial source and will work with Pioneer Hi-Bred to demonstrate the process on corn DNA molecules.

If the research project is successful, Los Alamos and Pioneer Hi-Bred will work together to develop a gene machine for use at Pioneer's Iowa laboratories.

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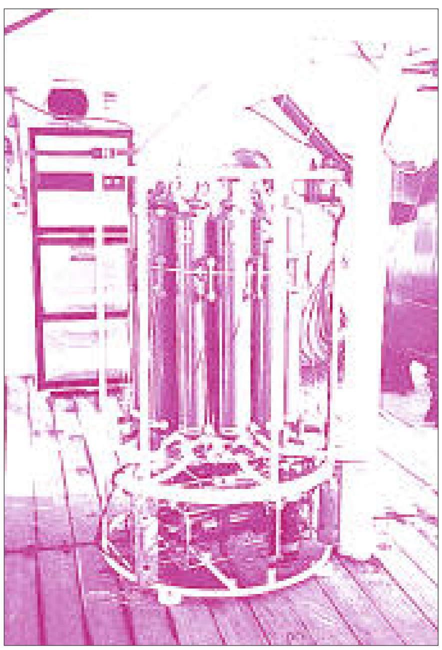
OCEAN FLORA FEAST ON LOS ALAMOS LEFTOVERS IN CLIMATE STUDY

BYPRODUCT OF RADIOISOTOPE PRODUCTION USED TO PREDICT GLOBAL CLIMATE CHANGE

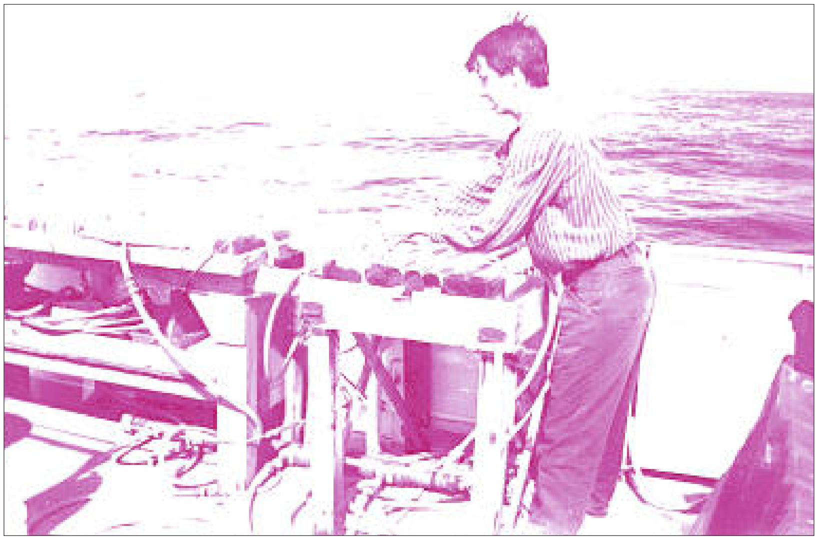
Scientists use computer models to predict how carbon dioxide and other greenhouse gases affect world climate. However, the complex interactions between oceans, atmosphere, land, and sun make precise climatic predictions very difficult. Oceans play a significant role in shaping the world climate because they store and move heat and gases around the planet. To better understand the relation between the atmosphere and the coastal regions of the oceans, Los Alamos and University of California at Santa Barbara researchers are studying nutrient metabolism in populations of single-cell phytoplankton plant life in Monterey Bay, Calif.



➔ This sampling device was used to collect water samples in Monterey Bay, Calif. This is the first step in measuring the uptake of silicon by algae.

Of particular interest are diatoms, a type of algae that produces a protective opaline silica shell. Studying their uptake of silicon will provide essential information for modeling the effects of greenhouse gases on global climate. The researchers believe the diatoms could play a major role in influencing climate change.

When ocean conditions change, such as increases in the amount of dissolved carbon dioxide caused by upwelling from the deeper waters, the diatoms “bloom,” and reproduce rapidly.



After water samples are recovered, a silicon-32 tracer is added to the samples, which are then incubated in temperature conditions similar to the depths from which they were retrieved. Here, U.C. Santa Barbara researcher Mark Brzezinski prepares the samples for incubation.

During blooms, their consumption of nutrients containing silicon, carbon, phosphorus, and nitrogen also increases. After they die, diatoms sink to the bottom of the ocean carrying with them the carbon and silicon stored in their shells. This results in a net removal of carbon from the atmosphere.

The right concentrations of carbon, phosphorus, nitrogen, and silicon are needed to sustain a bloom. However, because of a shorter supply of silicon than of the other nutrients, it is typically the first to be consumed. For this reason, researchers think silicon may be the limiting nutrient that determines how often and how long the diatoms bloom.

The researchers are studying the uptake of silicon by diatoms by measuring the amount of radioactive silicon-32 incorporated into the diatoms' shells after a controlled incubation experiment.

In the past, biological oceanographers studied the diatoms' silicon uptake with a mass spectrometer and a nonradioactive tracer isotope, silicon-30, but the technique is tedious, time-consuming, and expensive. By using silicon-32, a radioactive tracer, with radioanalytical methods, researchers get results in hours rather than months.

Because the silicon-32 decays to phosphorus-32, which also is radioactive and taken up by the diatoms, researchers need an analytical method that distinguishes between the emissions of the two isotopes. In a laboratory this would normally be done by the technique of liquid scintillation counting.

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However, scintillation counting instrumentation is expensive and difficult to use on a rocking ship for "real-time" analysis. So, researchers developed a simple analytical method that uses a gas-flow proportional counting device that is portable, inexpensive, and seaworthy. This method provides a way to measure the uptake of both silicon and phosphorus while still at sea.

The Los Alamos-U.C. Santa Barbara team, funded by a Los Alamos Directed Research and Development collaborative grant, tested the new technique on a recent research cruise in Monterey Bay.

The research vessel was provided by the Moss Landing Marine Laboratories and funded by the National Science Foundation. The research team also included scientists from the University of Southern California and the Monterey Bay Aquatic Research Institute.

At numerous locations in the bay, the researchers sent an instrumented sampling device into varying ocean depths. The device measured water temperature, amount of sunlight, ocean salinity, and amount of microorganism fluorescence activity. Based on the information from the instruments aboard the device, the team triggered the closure of large bottles on the device to collect water samples at known depths.

➔ After incubation, a filtering device separates the diatoms from the water samples.

When the researchers recovered the sampling device, they added the silicon-32 tracer to the samples of collected water and incubated them in an environment with light and temperature conditions similar to the depths from which they were retrieved.

After the incubation period, the researchers filtered the organisms and counted the silicon-32 and phosphorus-32 decay with the portable counter. They were able to calculate the

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➔ Los Alamos researcher Dennis Phillips uses a portable device to count the silicon-32 and phosphorus-32 decay. The final step in measuring the uptake of silicon by diatoms is to analyze the data collected. The results determine the diatoms' impact on the climate.

amount of silicon and phosphorus consumed by the organisms and determine the rate of uptake of the nutrients. These data will determine the impact of these microorganisms on the atmospheric carbon content and thus upon the global climate.

Los Alamos is the only institution in the world that makes and recovers silicon-32, a byproduct of a technology used to produce aluminum-26. One of many research radioisotopes produced at Los Alamos, aluminum-26 is used in biological studies into the causes of Alzheimer's disease and in material science experiments.

Los Alamos has produced research radioisotopes for medical, environmental, and basic science research for more than 20 years. The isotopes are recovered and distributed under the auspices of the Department of Energy Office of Isotope Production and Distribution.

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BRIEFLY ...

LOS ALAMOS SIGNS AGREEMENT WITH INDUSTRY TO MANUFACTURE HD-ROM TECHNOLOGY. Los Alamos and NorSam Technologies Inc. from Santa Fe recently signed an exclusive patent license agreement that gives NorSam rights to market the High-Density Read-Only Memory, or HD-ROM, technology invented at Los Alamos. (See related article in the November 1995 *Dateline: Los Alamos*.) Storage capacity of HD-ROM on steel, iridium, or silicon is 10,000 times greater than that of a compact disc and costs less to produce. HD-ROM technology could replace current archival media such as microfilm and is expected to last for thousands of years — withstanding misuse and natural degradation. NorSam plans to construct a plant in northern New Mexico to manufacture the ion-beam micromill, or data writer, that etches information onto HD-ROM media. The manufacturing plant is expected to provide about 300 jobs.

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