AAAS

Janet Raloff and Richard Lipkin report from Atlanta at the American Association for the Advancement of Science annual meeting

Pharming rubber trees

In recent years, biotechnologists have begun inserting genes for human hormones and other important proteins into barnyard animals. They hope to induce goats, cows, and sheep to express such genes when they lactate (SN: 9/7/91, p.148). Drug companies can then milk the animals for natural pharmaceuticals — such as insulin, growth hormone, and tissue plasminogen activator (TPA), which dissolves blood clots.

But a team of Malaysian researchers believes those scientists are barking up the wrong tree. Milk the latex of genetically engineered rubber trees (*Hevea brasiliensis*) instead, argues Hoong Yeet Yeang, a plant physiologist who directs biotechnology programs for the Rubber Research Institute of Malaysia in Kuala Lumpur.

Yeang's team successfully inserted the gene for a nondrug protein into *H. brasiliensis* tissue. The inserted DNA contained a "promoter" DNA sequence (derived from the 35-S cauliflower mosaic virus) to rev up the trees' genetic activity. They expected this virus to spur the genetically modified plants to produce detectable amounts of the test protein — the enzyme beta-glucuronidase (GUS) — throughout the tree. Instead, the gene promoter actually concentrated GUS production in the latex, Yeang reported at the meeting.

Though rubber trees can exude latex from the seedling stage on, harvesting sap takes its toll on plant growth. As a result, Yeang says, "you would not want to begin tapping trees too early" — probably not for at least the first 30 months. But a mature, 5-year-old tree produces 100 to 200 milliliters of sap every other day and continues doing so for 30 years. Because latex is sterile, he adds, one doesn't have to worry about the germs — including HIV — that can contaminate some pharmaceuticals now harvested from blood, including insulin.

The researchers have established the foreign protein's presence by staining tree tissue with a compound that highlights GUS. But they have not yet quantified how much GUS the latex contains, how concentrated a product can be purified from the latex, or even whether genes for actual drug products will behave similarly to GUS'. Answers should emerge from studies now under way to investigate the ability of transgenic rubber trees to produce insulin, Yeang says.

How much drug might a rubber tree make? Assuming the sap's concentration of foreign protein — such as TPA — matched that seen in TPA-laced milk from transgenic goats, a single tree yielding 200 ml of latex could produce 600 milligrams of harvestable drug per tapping, Yeang calculates. Today, he says, that much TPA sells for about $13,000.

Genes for healthier plants

Like people, plants depend on strong genetic constitutions to give them disease resistance.

Biologist Barbara N. Kunkel of Washington University in St. Louis and her colleagues report identifying, cloning, and characterizing a new gene for disease resistance in plants. Kunkel found the new RPS2 gene in *Arabidopsis thaliana*, a common weed, though she believes it may actually be widespread among plants. The gene enables a plant to make a big protein that helps fend off *Pseudomonas syringae*, a plant-damaging bacterium. Kunkel maintains that genetic engineers may find a way to introduce the gene into cash crops that need a boost in their immunity — perhaps even corn, beans, and tomatoes.

On a related front, biologist Roger Innes of Indiana University in Bloomington says he is attempting to insert into soybeans the disease resistance gene RPS3, found in wild mustard plants. Adding several resistance genes into one plant, he believes, may yield hardier crops that can fend off a much wider variety of pathogens.

Earth Science

A snail's take on climate change

The snails know. So do the limpets, barnacles, anemones, chitons, sea stars, and crabs living along the shore of Monterey Bay, Calif. While humans continue to debate how global warming will alter societies and ecosystems, this intertidal community is already showing changes linked to rising temperatures, reports a team of California scientists in the Feb. 3 Science.

James P. Barry of the Monterey Bay Aquarium Research Institute and his colleagues tracked shifts in the intertidal ecosystem by taking a census of the animals living in a 100-meter-long stretch of beach belonging to Stanford University's Hopkins Marine Station. They compared their counts with those compiled by Stanford researcher W.G. Hewatt, who studied the same patch of coastline in the early 1930s. Brass bolts sunk into the seaside granite by Hewatt enabled Barry and his colleagues to locate the original study area.

In the 61 years between surveys, the population of intertidal denizens shifted in favor of species that prefer warmer water. The researchers noted statistically significant increases in eight of nine southern species living in Monterey Bay. Conversely, five of eight northern species suffered declines.

A gradually warming climate could explain the southern takeover, the scientists say. The annual average water temperature at the shoreline in this area increased by 0.75°C during the past 60 years, while summer maximum water temperatures have climbed 2.2°C since the 1920s.

The scientists also note that El Niño warmings may have played some role. Such episodes are known to cause short-term changes in marine ecosystems. But the researchers argue against a major El Niño influence, because both Hewatt's study and the present one followed decades with similar numbers of El Niños.

Eastern quakes recycle old faults

In studies of earthquake hazards, a giant question mark looms over eastern North America. Although damaging shocks have rocked the East in the past, the rarity of historical jolts and the deep location of modern quakes stymie scientists trying to pinpointing which faults will trigger future shakes. Now, one geologist presents a theory that could bring eastern quakes into better focus.

In the February Geology, Russell L. Wheeler of the U.S. Geological Survey in Denver, Colo., suggests that most earthquakes in the Appalachian region occur on a particular set of ancient faults. Called Iapetan faults, these structures formed over 600 million years ago, when the ancestral North American continent ripped away from lands lying farther to the east. This rifting created the Iapetus Ocean, a predecessor of the Atlantic.

When earthquakes occur east of the Rocky Mountains, seismologists and geologists generally cannot tell which faults to blame. But Wheeler noticed a common theme among seismically active areas in the Appalachian belt. Earthquakes in the St. Lawrence River Valley and in southwestern Virginia take place on structures that run northeast-southwest and ramp downward toward the ocean. In both cases, evidence suggests that the faults formed during Iapetan times, Wheeler says. Despite less definitive information for other sites, he makes a similar argument for quakes in eastern Tennessee, western New York, and a handful of locations along the northwestern edge of the Appalachians.

Although ancient, the northeast-trending Iapetan faults are oriented in a way that absorbs the stresses generated today by the opening of the Atlantic Ocean, suggests Wheeler. If his theory stands up to scrutiny, it would help seismologists map future quake hazards in the Appalachian region, he says.