Agriculture

How the lab garden grows

The ability to generate complete plants from individual cells or small amounts of tissue is a requirement of agricultural biotechnology. Some plants have been amenable to such regeneration — carrot, alfalfa, potato, tobacco, petunia, periwinkle and rose. "It is disappointing that there has been little success with some of our major crops," says Joseph E. Varner of Washington University in St. Louis in "Frontiers in Science and Technology," a recent report of the National Academy of Sciences. "Although successful regeneration of a whole plant from a single cell or from a single protoplast [a cell whose wall has been removed] is still more of an empirical art than a closely reasoned science, each year more species are added to the list of plants for which regeneration is possible," Varner says.

Two recent announcements by specialty agricultural biotechnology companies add plants to that list. Cotton plants have been regenerated from tissue samples at Phytogen of Pasadena, Calif. "The ability to grow cotton plants from tissue cultures means that we can now begin to work on ways to genetically manipulate cotton," says David Anderson of Phytogen. Another company, ARCO Solar Industries, has announced regeneration of tomatoes from protoplasts. The technique succeeded in 11 tomato cultivars tested, including processing, freshmarket and cherry tomato types. The company expects their method to be applicable to other crop plants. Both companies are seeking patents for their regeneration processes.

Fruit orchards as well as crop plants may benefit from new techniques. Regeneration of black cherry trees from tissue from mature plants has been achieved by scientists at State University of New York at Syracuse. David M. Tricoli, Allen P. Drew and Charles A. Maynard start with the dome of genetically stable embryonic tissue at the tip of cherry tree buds. The tissue is grown one to three months in the laboratory in a blend of fertilizer and hormones until it produces small shoots. These shoots then are transferred to media containing a different blend of hormones, where they grow roots and eventually are transferred to soil. The plants can be moved to the field a year after the original tissue was obtained. Traditionally, such seedlings are obtained from a seed orchard, a process that takes 15 to 20 years, or from grafted plants, an operation costing about $10 per tree. The New York researchers predict the cost with the tissue culture technique could be as low as 22 cents per tree.

More chemicals mimic insects

For 20 years scientists have been synthesizing chemicals that duplicate substances insects release to convey messages to other members of their species. Currently there are more than 60 such pheromones commercially available for insect control, and research continues to reveal new pheromones. The U.S. Department of Agriculture has announced isolation, identification and synthesis of a mixture of three components produced by imported red fire ant queens. Scientists at USDA laboratories in Gainesville, Fla., have demonstrated that inanimate objects treated with queen extracts are carried back to the nest and placed near the actual queen. The scientists speculate that a mixture of toxic chemicals combined with the new pheromone would be rapidly delivered to the heart of the colony, where it would kill ants effectively.

Other laboratory-produced compounds are being enlisted in the fight against pests doing serious damage to California's avocado crops. They mimic two pheromones emitted by two groups of female Amorbia moth to attract males for mating. J. Blair Bailey of the University of California Cooperative Extension has used the substance in field tests where it lured male moths into sticky traps. The pheromones were synthesized by Les McDonough of the U.S. Department of Agriculture's laboratory in Yakima, Wash.

Biomedicine

Joan Arehart-Treichel reports from Dearborn, Mich., at an international symposium on clinical disorders of bone and mineral metabolism

Vitamin D and hip fractures

Hip fractures in older people appear to be due, at least in part, to a vitamin D deficiency, two new studies suggest. But the studies do not agree on the means.

Samuel H. Doppelt and co-workers at Massachusetts General Hospital in Boston examined 142 elderly hip fracture patients for vitamin D levels and found that 40 percent were vitamin D deficient, suggesting a causative association between vitamin D deficiency and hip fractures. What's more, three-fourths of these patients had osteomalacia (inadequate mineralization of bone due to vitamin D deficiency). Thus, one means by which vitamin D causes hip fractures, at least in some patients, is via osteomalacia, the researchers conclude.

Researchers at Vrije University in Amsterdam, headed by Paul Lips, studied 125 hip fracture patients and 74 age-matched controls. They found less vitamin D in patients than in controls. In contrast to Doppelt and his team, however, they did not find any serious osteomalacia in hip tissue taken from their patients. But they did find loss of cortical bone in the tissue. Because vitamin D deficiency was already known to be capable of causing cortical bone loss, they conclude that this loss helps cause hip fractures among the elderly.

Sulfur and bone mineralization

Several years ago Larry Arsenault and colleagues at the Ontario Cancer Institute developed a technique called electron spectroscopic imaging (ESI). It allowed visualization, for the first time, of the spatial distribution of atomic elements within biological tissue (SN: 1/10/81, p. 20). And recently the Toronto scientists have been using the technique to learn more about the involvement of various elements in bone mineralization — the formation of calcium phosphate crystals (which harden bone) from the combination of calcium and phosphorus.

Contrary to what they had expected, they did not find calcium and phosphorus to be located close to each other in bone that was in the early process of mineralization. Also to their surprise, they found sulfur to be in essentially the same locations that calcium was. Yet at a later stage of mineralization, there was a virtual superimposition of calcium with both sulfur and phosphorus. These findings, Arsenault says, suggest that sulfur is intimately associated with the bone mineralization process, and that it may somehow get calcium and phosphorus to combine to form calcium phosphate crystals.

Exercise and osteoporosis

Currently the only means available for preventing postmenopausal bone loss and subsequent osteoporosis (spinal fractures) is estrogen replacement therapy, which also increases the risk of uterine cancer. Now, though, new research results suggest that there is another effective preventive as well—exercise that puts weight on bone, such as tennis, running or jogging.

Such exercise—known as weight-bearing exercise—has been well established to strengthen bone in younger people. So Peter Jacobson and co-workers at the University of North Carolina at Chapel Hill hypothesized that weight-bearing exercise might counter the bone loss that invariably follows menopause. They studied 80 women ages 35 to 65 years who played tennis three times a week and 400 age-matched sedentary women to see whether this was true.

The tennis players aged 35 to 55 years did not have much more bone than controls, the researchers found. This was what they expected, since women do not lose bone before menopause and since women generally do not become menopausal until 45, 50 or even 55 years of age. However, the players aged 55 to 65 had much more bone than controls, implying that tennis can prevent, or at least slow, postmenopausal bone loss.