

The annuals that his team studied in the desert belong to the same family as sunflowers (*Compositae*). To find out what other plants might survive, the Safat team tainted the sand in greenhouse pots to match the petroleum concentrations in which the wildflowers had been growing—10 percent crude oil by weight. Most of the corn, barley, wheat, termis (a legume), and tomatoes planted in this oiled sand not only germinated but grew into healthy-looking plants, albeit 25 to 40 percent smaller than those raised in clean sand. Naturally occurring microbes also kept roots growing in the tainted sand free of oil.

Oil alone entices many petroleum-noshing bugs to immigrate to polluted areas. However, the rich nutrients exud-

ed by plant roots—such as sugars, amino acids, oxygen, and vitamins—make that environment even more welcoming, Radwan observes. For this reason, his team recommends “densely cultivating suitable plants in polluted Kuwaiti desert areas as a promising approach for their bioremediation.”

In fact, this “solar-powered system may find very wide application in many different parts of the world and with many different contaminants,” argues toxicologist Barbara T. Walton of Oak Ridge (Tenn.) National Laboratory.

Other groups, her own included, have reported evidence that root-zone microbes have the potential to degrade a number of noxious contaminants, from organic solvents and TNT to per-

sistent pesticides. Critics, however, have questioned the prospects for such “phytoremediation” under the extreme conditions that can plague polluted sites. Now, Walton says, Radwan’s team “offers in-your-face evidence that this [phytoremediation] can clean up a contaminant of widespread concern—oil—under extreme conditions.”

What’s more, phytoremediation could cost far less than conventional cleanup technologies, notes Burt Ensley of Phytotech in Monmouth Junction, N.J.

Because soil-cleaning plants may absorb some of the toxic materials around them, Walton believes that the trick will be to identify plants for cultivation that won’t tempt growers or wildlife to dine on them. —J. Raloff

Circuitry simulates genetic networks

Thinking of organisms as chemical machines has become commonplace among biologists. But following through on that metaphor by mapping out all the molecular mechanisms, feedback loops, and signaling pathways of even one microorganism has proved to be an extraordinarily difficult task.

So many mechanisms signal each other at once that researchers liken a cell’s information-processing network to a telephone system.

For Harley H. McAdams, a physicist formerly with Bell Laboratories in Murray Hill, N.J., and Lucy Shapiro, a molecular biologist at Stanford University School of Medicine, that comparison turned out to be more than just an analogy. Together, they have devised a circuit diagram to describe the major signaling pathways of a common bacteriophage.

Those signaling pathways, they explain in the Aug. 4 *SCIENCE*, depend on clusters of genes that operate in concert to yield fully functional biological mechanisms. Such genetic networks, comprising several hundred genes, “are difficult to analyze with currently available techniques,” they state.

Capitalizing on the parallel functions of genetic “circuits” and electric circuits, they have adopted a “hybrid modeling approach” that integrates biochemistry into ordinary circuit diagrams. In this way, they can account for the choice of replicative strategies the bacteriophage lambda makes after infecting *Escherichia coli*.

“In some sense, this is the next step for the genome project,” says Shapiro. “Scientists are sequencing lots of genes, then trying to figure out how they relate to each other in a given cell.

“But unless we can analyze logically how these genes work together, we’ll never understand how organisms work,” she adds. “This method provides a sys-

tematic way of thinking about complex networks of genes.”

McAdams admits that a great disparity exists in time scales between genetic switching circuits and electric switching circuits, but he observes that the two have much in common.

In electric circuits, the flow of electrons defines connection pathways. Similarly, chemical signals carried by proteins constitute a pathway. Moreover, because many biochemical paths flow at the same time, microorganisms, despite their tiny volumes, are capable of processing a tremendous amount of information.

This feature permits enormous amounts of “genetic computation within any living organism,” McAdams and Shapiro state.

“This model is a beautiful piece of

work,” says William F. Loomis, a biologist at the University of California, San Diego, who wrote a commentary accompanying the report, “because it works. The output fits the measured data,” he adds. “All of the parameters are reasonable. It’s robust. That constitutes a tremendous success.”

By describing one genetic network, Loomis points out, McAdams and Shapiro have effectively challenged others to describe similar networks “controlling such things as cancer, growth, or aging.

“In biology, a single gene rarely works alone,” he continues. “Genes work in networks. So genetic networks are the real unit of evolutionary selection.”

“This is a new viewpoint that I think will greatly impact how we look at genetic data,” Loomis concludes. “I think that’s pretty important.”

—R. Lipkin

Faulty seals delay shuttle

It wasn’t just a routine delay that prevented the space shuttle Endeavour from taking off as planned on Aug. 5. NASA announced late last month that it has postponed the flight until at least mid-August, while the agency struggles with a problem it discovered in rocket boosters after the last two shuttles returned to Earth. Tiny leaks from burning fuel had slightly scorched O-ring seals between metal joints at the nozzle of the boosters, which are reused on other flights.

NASA scientists emphasize that the leaks differ in several ways from those that led to the fatal explosion of the Challenger shuttle in 1986. The redesigned O-rings seal a different joint in the booster. And in contrast to the rings used in 1986, which failed to maintain a good seal after being subjected to freezing temperatures on the launch pad, neither the current rings

nor the surrounding joints appear to have a design flaw.

Instead, engineers believe that the scorch marks, which resemble pinpricks no more than a few thousandths of an inch deep, stem from the way technicians apply a rubberlike compound that serves as one of several thermal barriers between the hot gas and the O-rings. Tiny holes somehow created in the compound appear to channel the fuel to the O-rings. In 11 previous instances, investigators had found such channels, but they had not found burn marks in those cases.

At a press briefing at NASA’s Johnson Space Center in Houston last week, NASA shuttle operations director Brewster Shaw said he was hopeful that engineers could correct the problem in a few weeks, perhaps at the launch pad. Further delays could postpone an October linkup between the Atlantis shuttle and Mir, the Russian space station (SN: 5/20/95, p.312). —R. Cowen