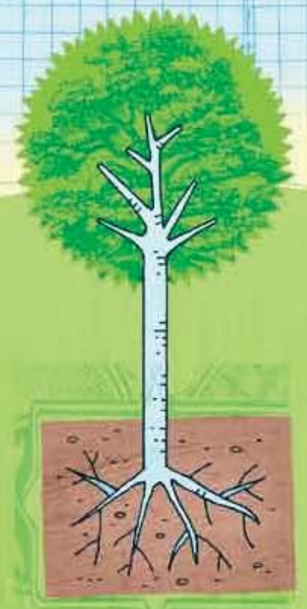
ON THE GROUND:

Microbial Communities

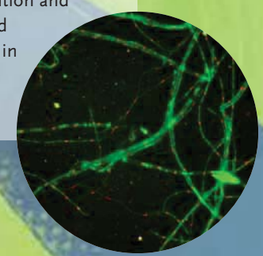
Here are just a few CNR projects happening on the ground with microbial communities.

Illustration by Clive Goodyer



WHAT MAKES MICROORGANISMS TICK?

Using methods that recover the genome sequences and identify the proteins and other small organic molecules in natural microbial community samples, geomicrobiologist and biogeochemist **Jill Banfield** studies the effects of inter-organism interactions and environmental geochemical controls on the activities of microorganisms and microbial communities. Her lab uncovers genomic variations that shed light on evolution and natural selection. Current work includes the use of stimulated microbial activity for bioremediation of metal contamination in natural environments; investigations of microbial adaptation to extreme environments; and the early colonization of the premature human infant gut.



FUNGUS-ROOT MUTUALISM

Plant and microbial biology (PMB) professor **Thomas Bruns'** lab focuses on the ecology and evolution of mycorrhizal fungi. These helpful microbes form symbiotic associations with plant roots, and this interaction represents one of the most widespread and important mutualisms in soil-based ecosystems. Current work includes using genomic information to study various species associated with pine, indoor air, and energy crops. His lab is also working to catalog the fungal species of Point Reyes National Seashore and Yosemite National Park.

SOIL MICROBES AND PLANT-ROOT INTERACTIONS

Soil microbes comprise the primary workforce for the development of nutrients in soil. In addition to mediating the transfers of nitrogen between the biosphere and atmosphere, they are almost totally responsible for the production of two key greenhouse gases, nitrous oxide and methane. Graduate students and postdocs working with soil microbial ecologist and professor **Mary Firestone** explore the complex community ecology underlying soil microbial nutrient cycling, as well as microbial interactions with plant roots; root-microbe interactions influence not only plant growth but also soil nutrient transformations, such as decomposition processes.

USING GENOMES TO UNDERSTAND ADAPTATION

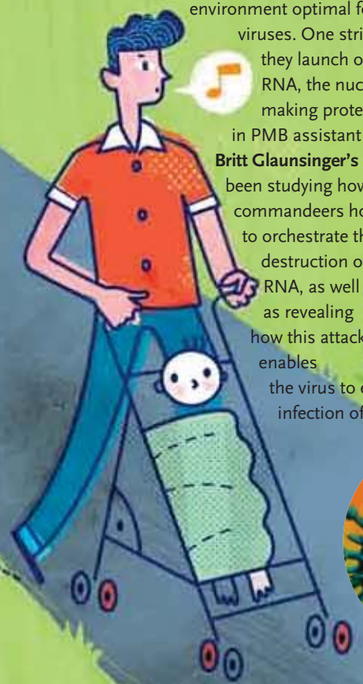
Entire fields of laboratory microbiology benefit from studying one strain. Conversely, evolutionary biologists benefit by exploiting the natural variation seen among strains. Laboratory researchers love phenotypes that change when they mutate one gene and evolutionary biologists love adaptive phenotypes based on many genes. Inexpensive whole-genome sequencing is merging these two fields. PMB professors **John Taylor** and **N. Louise Glass** and Molecular and Cell Biology (MCB) assistant professor **Rachel Brem** are comparing genomes of populations of the fungus *Neurospora* to find groups of genes hypothesized to be responsible for adaptation, and then testing the hypotheses, one gene mutation at a time.

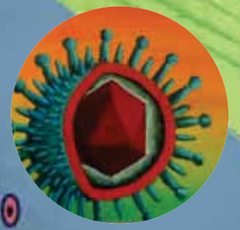
CONTROLLING A GRAPE KILLER

PMB professor **Steve Lindow** studies the bacterium *Xylela fastidiosa*, which causes Pierce's disease, lethal to grape vines. This pathogen has a complicated lifestyle that includes colonizing the xylem vessels — the veins of the plant, where it blocks water flow — and also the mouthparts of sap-sucking insects that vector it from plant to plant (see News Briefs, page 4).

UNDERSTANDING THE HERPES VIRUS

Herpes viruses are masterful manipulators. Not only are they impossible to eliminate once infection has established, but they can also reprogram the host cells to create an environment optimal for replicating more viruses. One striking example is the attack they launch on cellular messenger RNA, the nucleic acid necessary for making proteins. Researchers in PMB assistant professor **Britt Glaunsinger's** lab have been studying how the virus commandeers host enzymes to orchestrate the destruction of RNA, as well as revealing how this attack enables the virus to establish a successful infection of its host.



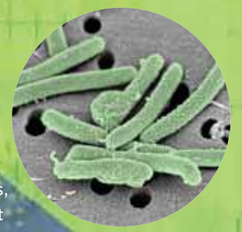


LEARNING FROM TERMITES

Nearly every environmental niche — from the soil we walk on to the oceans we swim in, and even our own bodies — is inhabited by a diverse community of microorganisms that together carry out functions that larger organisms are unable to perform on their own. By focusing on the exchange of corrinoid cofactors — vitamin B12 and its close cousins — and using the intestinal communities in termites as a model system, PMB assistant professor **Michi Taga** hopes to identify key factors that control the exchange of nutrients in microbial communities.

A TASTE FOR THE TOXIC

Bacteria can consume toxic molecules such as perchlorate, a putative cause of neuropsychological development deficiencies. Research in the lab of PMB professor **John Coates** focuses on microorganisms capable of removing this compound from the environment. Over the last decade this research has identified the diversity and ubiquity of these organisms and the underlying genes and enzymes, and has led to the development of several novel bioremediative technologies, not only for perchlorate but also nitrate, radionuclides, and other xenobiotics. Ongoing studies are investigating their ability to prevent biocorrosion of pipelines.



PHOTOS: Clockwise from bottom left: *Neurospora* colonies emerging from a plant that has been killed by a fire but not charred, Martin Bidartondo; microbes, courtesy of Jill Banfield Group; Pierce's disease, courtesy of Steve Lindow; termites, Seth Manu; toxin-eating microorganisms, courtesy of John Coates; herpes virus illustration, Debbie Sklur; soil microbes, courtesy of Mary Firestone